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AN

INTRODUCTION
TO
PHYSIOLOGICAL AND SYSTEMATICAL
BOTANY.

BY

JAMES EDWARD SMITH, M.D. F.R.S.
&c. &c.
PRESIDENT OF THE LINNÆAN SOCIETY.

"CONSIDER THE LILIES OF THE FIELD, HOW THEY GROW."

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TO
THE HONOURABLE AND RIGHT REVEREND
SHUTE,
LORD BISHOP OF DURHAM.

My Lord,

The circumstances which induce me to solicit your Lordship's protection for the following pages are such, that I trust they will ensure pardon for myself, and more indulgence for my performance than I might expect, even from your Lordship's usual goodness towards me.

The contents of these pages were, in a very unfinished state, honoured with the approbation and encouragement of an excellent and lamented lady, to whom they were destined to be offered in their present less unworthy condition. I should have been proud to have sheltered them under her patronage, because I have always found the most intelligent critics the most indulgent. Their general tendency at least, as calculated to render an interesting and useful *science accessible, and in every point eligible, to the more accomplished and refined of her own sex, could not fail to have been approved by her, who knew and exemplified so well the value and importance of such pursuits, and their inestimable effects upon the mind. These hopes, which my late honoured friend and patroness had, with her usual benignity, encouraged, are now most unhappily defeated, and I have no resource but in your Lordship, who is no stranger to my pretensions, nor to my sentiments, and in whom I have not now for the first time to seek an able and enlightened patron. I remain,*

with the profoundest respect,
my Lord,
your Lordship's most obliged
and obedient servant,

J. E. SMITH.

Norwich,
Nov. 15, 1807.

PREFACE.

AFTER the many elementary works on Botany which have appeared in various languages, any new attempt of the same kind may, at first sight, seem unnecessary. But when we consider the rapid progress of the science within a few years, in the acquisition and determination of new plants, and especially the discoveries and improvements in vegetable physiology: when we reflect on the views with which those fundamental works of Linnæus, the basis of all following ones, were composed, and to whom they were addressed, we must be aware of their unfitness for purposes of general and popular utility, and that something else is wanting. If we examine the mass of introductory books on botany in this light, we shall find them in some cases too elaborate and intricate, in others too obscure and imperfect: they are also deficient in that very pleasing and instructive part of botany the anatomy and physiology of plants. There are indeed works, such as Rose's *Elements of Botany*, and Darwin's *Phytologia*, with which no such faults can be found. The former is a compendium of Linnæan learning, the latter a store of ingenious philosophy; but they were designed for philosophers, and are not calculated for every reader. Linnæus and his scholars have generally written in Latin. They addressed themselves to physicians, to anatomists, to philosophers, little thinking that their science would ever be the amusing pursuit of the young, the elegant and the refined, or they would have treated the subject differently. It appears to me, therefore, that an introductory publication is still desirable in this country, on an original plan, easy, comprehensive, and fit for general use; and such were the reasons which first prompted me to the undertaking.

When, however, I had proceeded a considerable way in its execution, I found that such a work might not only serve to teach the first outlines of the science, but that it might prove a vehicle for many observations, criticisms, and communications, scarcely to be brought together on any other plan; nor did it appear any objection to the general use of the book, that, besides its primary intention, it might be capable of leading into the depths of botanical philosophy, whether physiological, systematical, or critical, any student who should be desirous of proceeding so far. A volume of this size can indeed be but elementary on subjects so extensive; but if it be clear and intelligible as far as it goes, serving to indicate the scope of the science of botany, and how any of its branches may be cultivated further, my purpose is answered. The subject has naturally led me to a particular criticism of the Linnæan system of arrangement, which the public, it seems, has expected from me. Without wasting any words on those speculative and fanciful changes, which the most ignorant may easily make, in an artificial system; and without entering into controversy with the very few competent writers who have proposed any alterations; I have simply stated the result of my own practical observations, wishing by the light of experience to correct and to confirm what has been found useful, rather than rashly to overthrow what perhaps cannot on the whole be improved.

As the discriminating characters of the Linnæan system are founded in nature and fact, and depend upon parts essential to every species of plant when in perfection; and as the application of them to practice is, above all other systems, easy and intelligible; I conceive nothing more useful can be done than to perfect, upon its own principles, any parts of this system that experience may show to have been originally defective. This is all I presume to do. Speculative alterations in an artificial system are endless, and scarcely answer any more useful purpose than changing the order of letters in an alphabet. The philosophy of botanical arrangement, or the study of the natural affinities of plants, is quite another matter. But it would be as idle, while we pursue this last-mentioned subject, so deep and so intricate that its most able cultivators are only learners, to lay aside the continual use of the Linnæan system, as it would be for philologists and logicians to slight the convenience, and indeed necessity, of the alphabet, and to substitute the Chinese character in its stead. If the following pages be found to elucidate and to confirm this comparison, I wish the student to keep it ever in view.

The illustration of the Linnæan system of classification, though essential to my purpose, is however but a small part of my aim. To explain and apply to practice those beautiful principles of method, arrangement and discrimination, which render botany not merely an amusement, a motive for taking air and exercise, or an assistance to many other arts and sciences; but a school for the mental powers, an alluring incitement for the young mind to try its growing strength, and a confirmation of the most enlightened understanding in some of its sublimest most important truths. That every path tending to ends so desirable may be accessible, I have not confined myself to systematical subjects, wide and various as they are, but I have introduced the anatomy and physiology of plants to the botanical student, wishing to combine all these several objects; so far at least that those who do not cultivate them all, may be sensible of the value of each in itself, and that no disgraceful rivalship or contempt, the offspring of ignorance, may be felt by the pursuers of any to the prejudice of the rest.

I have treated of physiological and anatonical subjects in the first place, because a true knowledge of the structure and parts of plants seems necessary to the right understanding of botanical arrangement; and I trust the most superficial reader will here find enough for that purpose, even though he should not be led to pursue these subjects further by himself. I have every where aimed at familiar illustrations and examples, referring, as much as possible, to plants of easy acquisition. In the explanation of botanical terms and characters, I have, besides furnishing a new set of plates with references to the body of the work, always cited a plant for my purpose by its scientific name, with a reference to some good and sufficient figure. For this end I have generally used either my own works *English* and *Exotic Botany*, all the plates of which, as well as of the present volume, are the performance of the same excellent botanist as well as artist; or *Curtis's Magazine*, some of which also was drawn by Mr. Sowerby, but the greater part by the no less ingenious Mr. Edwards. I have chosen these as the most comprehensive and popular books, quoting others only when these failed me, or when I had some particular end in view. If this treatise should be adopted for general use in schools or families, the teacher at least will probably be furnished with those works, and will accommodate their contents to the use of the pupils. I am aware of the want of a systematical English description of British plants, on the principles of this *Introduction*; but that deficiency I hope as soon as possible to supply. In the mean while Dr. Withering's work may serve the desired purpose, attention being paid only to his original descriptions, or to those quoted from English writers. His index will atone for the changes I cannot approve in his system. Wherever my book may be found deficient in the explanation of his or any other terms, as I profess to retain only what are necessary, or in some shape useful, the *Language of Botany*, by Professor Martyn, will prove extremely serviceable.

Having thus explained the use and intention of the present work, perhaps a few remarks on the recommendations of the study of Botany, besides what have already been suggested, may not here be misplaced.

I shall not labour to prove how delightful and instructive it is to

> "Look through nature up to Nature's God."

Neither, surely, need I demonstrate, that if any judicious or improved use is to be made of the natural bodies around us, it must be expected from those who discriminate their kinds and study their properties. Of the benefits of natural science in the improvement of many arts, no one doubts. Our food, our physic, our luxuries are improved by it. By the inquiries of the curious new acquisitions are made in remote countries, and our resources of various kinds are augmented. The skill of Linnæus by the most simple observation, founded however on scientific principles, taught his countrymen to destroy an insect, the *Cantharis navalis*, which had cost the Swedish government many thousand pounds a year by its ravages on the timber of one dockyard only. After its metamorphoses, and the season when the fly laid its eggs, were known, all its ravages were stopped by immersing the timber in water during that period. The same great observer, by his botanical knowledge, detected the cause of a dreadful disease among the horned cattle of the north of Lapland, which had previously been thought equally unaccountable and irremediable, and of which he has given an exquisite account in his Lapland tour, as well as under *Cicuta virosa*, *Engl. Bot. t.* 479, in his *Flora Lapponica*. One man in our days, by his scientific skill alone, has given the bread-fruit to the West-Indies, and his country justly honours his character and pursuits. All this is acknowledged. We are no longer in the infancy of science, in which its utility, not having been proved, might be doubted, nor is it for this that I contend. I would recommend botany for its own sake. I have often alluded to its benefits as a mental exercise, nor can any study exceed it in raising curiosity, gratifying a taste for beauty and ingenuity of contrivance, or sharpening the powers of discrimination. What then can be better adapted for young persons? The chief use of a great part of our education is no other than what I have just mentioned. The languages and the mathematics, however valuable in themselves when acquired, are even more so as they train the youthful mind to thought and observation. In Sweden Natural History is the study of the schools, by which men rise to preferment; and there are no people with more acute or better regulated minds than the Swedes.

To those whose minds and understandings are already formed, this study may be recommended, independently of all other considerations, as a rich source of innocent pleasure. Some people are ever inquiring "what is the use" of any particular plant, by which they mean "what food or physic, or what materials for the painter or dyer does it afford?" They look on a beautiful flowery meadow with admiration, only in proportion as it affords nauseous drugs or salves. Others consider a botanist with respect only as he may be able to teach them some profitable improvement in tanning, or dyeing, by which they may quickly grow rich, and be then perhaps no longer of any use to mankind or to themselves. They would permit their children to study botany, only because it might possibly lead to professorships, or other lucrative preferment.

These views are not blameable, but they are not the sole end of human existence. Is it not desirable to call the soul from the feverish agitation of worldly pursuits, to the contemplation of Divine Wisdom in the beautiful œconomy of Nature? Is it not a privilege to walk with God in the garden of creation, and hold converse with his providence? If such elevated feelings do not lead to the study of Nature, it cannot far be pursued without rewarding the student by exciting them.

Rousseau, a great judge of the human heart and observer of human manners, has remarked, that "when science is transplanted from the mountains and woods into cities and worldly society, it loses its genuine charms, and becomes a source of envy, jealousy and rivalship." This is still more true if it be cultivated as a mere source of emolument. But the man who loves botany for its own sake knows no such feelings, nor is he dependent for happiness on situations or scenes that favour their growth. He would find himself neither solitary nor desolate, had he no other companion than a "mountain daisy," that "modest crimson-tipped flower," so sweetly sung by one of Nature's own poets. The humblest weed or moss will ever afford him something to examine or to illustrate, and a great deal to admire. Introduce him to the magnificence of a tropical forest, the enamelled meadows of the Alps, or the wonders of New Holland, and his thoughts will not dwell much upon riches or literary honours, things that

> "Play round the head, but come not near the heart."

One idea is indeed worthy to mix in the pure contemplation of Nature, the anticipation of the pleasure we may have to bestow on kindred minds with our own, in sharing with them our discoveries and our acquisitions. This is truly an object worthy of a good man, the pleasure of communicating virtuous disinterested pleasure to those who have the same tastes with ourselves; or of guiding young ingenuous minds to worthy pursuits, and facilitating their acquisition of what we have already obtained. If honours and respectful consideration reward such motives, they flow from a pure source. The giver and the receiver are alike invulnerable, as well as inaccessible, to "envy, jealousy or rivalship," and may pardon their attacks without an effort.

The natural history of animals, in many

respects even more interesting than botany to man as an animated being, and more striking in some of the phænomena which it displays, is in other points less pleasing to a tender and delicate mind. In botany all is elegance and delight. No painful, disgusting, unhealthy experiments or inquiries are to be made. Its pleasures spring up under our feet, and, as we pursue them, reward us with health and serene satisfaction. None but the most foolish or depraved could derive any thing from it but what is beautiful, or pollute its lovely scenery with unamiable or unhallowed images. Those who do so, either from corrupt taste or malicious design, can be compared only to the fiend entering into the garden of Eden.

Let us turn from this odious picture to the contemplation of Nature, ever new, ever abundant in inexhaustible variety. Whether we scrutinize the damp recesses of woods in the wintry months, when the numerous tribes of mosses are displaying their minute but highly interesting structure; whether we walk forth in the early spring, when the ruby tips of the hawthorn-bush give the first sign of its approaching vegetation, or a little after, when the violet welcomes us with its scent, and the primrose with its beauty; whether we contemplate in succession all the profuse flowery treasures of the summer, or the more hidden secrets of Nature at the season when fruits and seeds are forming; the most familiar objects, like old friends, will always afford us something to study and to admire in their characters, while new discoveries will awaken a train of new ideas. The yellow blossoms of the morning, that fold up their delicate leaves as the day advances; others that court and sustain the full blaze of noon; and the pale night-scented tribe, which expand, and diffuse their very sweet fragrance, towards evening, will all please in their turn. Though spring is the season of hope and novelty, to a naturalist more especially, yet the wise provisions and abundant resources of Nature, in the close of the year, will yield an observing mind no less pleasure, than the rich variety of her autumnal tints affords to the admirers of her external charms. The more we study the works of the Creator, the more wisdom, beauty and harmony become manifest, even to our limited apprehensions; and while we admire, it is impossible not to adore.

"Soft roll your incense, herbs, and fruits, and flowers,
In mingled clouds, to *Him*, whose sun exalts,
Whose breath perfumes you, and whose pencil paints!"

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INTRODUCTION

TO

PHYSIOLOGICAL AND SYSTEMATICAL

BOTANY.

CHAPTER I.

DISTINCTIONS BETWEEN ANIMALS, VEGETABLES, AND FOSSILS.—ON THE VITAL PRINCIPLE ESSENTIAL TO THE TWO FORMER.

THOSE who with a philosophical eye have contemplated the productions of Nature, have all, by common consent, divided them into three great classes, called the Animal, the Vegetable, and the Mineral or Fossil Kingdoms. These terms are still in general use, and the most superficial observer must be struck with their propriety. The application of them seems at first sight perfectly easy, and in general it is so. Difficulties occur to those only who look very deeply into the subject.

Animals have an organized structure which regularly unfolds itself, and is nourished and supported by air and food; they consequently possess life, and are subject to death; they are moreover endowed with sensation, and with spontaneous, as well as voluntary, motion.

Vegetables are organized, supported by air and food, endowed with life and subject to death as well as animals. They have in some instances spontaneous, though we know not that they have voluntary, motion. They are sensible to the action of nourishment, air, and light, and either thrive or languish according to the wholesome or hurtful application of these stimulants. This is evident to all who have ever seen a plant growing in a climate, soil, or situation, not suitable to it. Those who have ever gathered a rose, know but too well how soon it withers; and the familiar application of its fate to that of human life and beauty is not more striking to the imagination than philosophically and literally true. The sensitive plant is a more astonishing example of the capability of vegetables to be acted upon as living bodies. Other instances of the same kind we shall hereafter have occasion to mention.

The spontaneous movements of plants are almost as readily to be observed as their living principle. The general direction of their branches, and especially of the upper surface of their leaves, though repeatedly disturbed, to the light; the unfolding and closing of their flowers at stated times, or according to favourable or unfavourable circumstances, with some still more curious particulars to be explained in the sequel of this work, are actions undoubtedly depending on their vital principle, and are performed with the greater facility in proportion as that principle is in its greatest vigour. Hence arises a question whether Vegetables are endowed with sensation. As they possess life, irritability and motion, spontaneously directing their organs to what is natural and beneficial to them, and flourishing according to their success in satisfying their wants, may not the exercise of their vital functions be attended with some degree of sensation, however low, and some consequent share of happiness? Such a supposition accords with all the best ideas we can form of the Divine Creator; nor could the consequent uneasiness which plants must suffer, no doubt in a very low degree likewise, from the depredations of animals, bear any comparison with their enjoyment on the whole. However this may be, the want of sensation is most certainly not to be proved with regard to Vegetables, and therefore of no use as a practical means of distinguishing them, in doubtful cases, from Animals.

Some philosophers* have made a locomotive power peculiarly characteristic of Animals, not being aware of the true nature of those half-animated beings called Corals and Corallines, which are fixed, as immoveably as any plants, to the bottom of the sea, while indeed many living vegetables swim around them, unattached

* Jungius, Boerhaave, Ludwig and many others.

to the soil, and nourished by the water in which they float. Some* have characterized Animals as nourished by their internal, and Vegetables by their external surface, the latter having no such thing as an internal stomach. This is ingenious and tolerably correct; but the proofs of it must fail with respect to those minute and simply-constructed animals the Polypes, and the lower tribes of Worms, whose feelers, put forth into the water, seem scarcely different from roots seeking their food in the earth, and some of which may be turned inside out, like a glove, without any disturbance of their ordinary functions. The most satisfactory remark I have for a long time met with on this difficult subject is that of M. Mirbel, in his *Traité d'Anatomie et de Physiologie Végétales*†, a work I shall often have occasion to quote. He observes, *vol.* i. *p.* 19, "that plants alone have a power of deriving nourishment, though not indeed exclusively, from inorganic matter, mere earths, salts or airs, substances certainly incapable of serving as food for any animals, the latter only feeding on what is or has been organized matter, either of a vegetable or animal nature. So that it should seem to be the office of vegetable life alone to transform dead matter into organized living bodies." This idea appears to me so just, that I have in vain sought for any exception to it.

Let us however descend from these philosophical speculations to purposes of practical utility. It is sufficient for the young student of Natural History to know, that in every case in which he can be in doubt whether he has found a plant or one of the lower orders of animals, the simple experiment of burning will decide the question. The smell of a burnt bone, coralline, or other animal substance, is so peculiar that it can never be mistaken, nor does any known vegetable give out the same odour.

---

* Dr. Alston, formerly professor of botany at Edinburgh.

† Published at Paris a few years since, in two vols. 8vo.

The Mineral Kingdom can never be confounded with the other two. Fossils are masses of mere dead unorganized matter, subject to the laws of chemistry alone; growing indeed, or increasing by the mechanical addition of extraneous substances, or by the laws of chemical attraction, but not fed by nourishment taken into an organized structure. Their curious crystallization bears some resemblance to organization, but performs none of its functions, nor is any thing like a vital principle to be found in this department of Nature.

If it be asked what is this vital principle, so essential to animals and vegetables, but of which fossils are destitute, we must own our complete ignorance. We know it, as we know its Omnipotent Author, by its effects.

Perhaps in the fossil kingdom *heat* may be *equivalent* to a vital principle; but heat is not the vital principle of organized bodies, though probably a consequence of that principle.

Living bodies of animals and plants produce heat; and this phænomenon has not, I think, been entirely explained on any chemical principles, though in fossils the production of heat is in most cases tolerably well accounted for. In animals it seems to have the closest possible connexion with the vital energy. But the effects of this vital energy are still more stupendous in the operations constantly going on in every organized body, from our own elaborate frame to the humblest moss or fungus. Those different fluids, so fine and transparent, separated from each other by membranes as fine, which compose the eye, all retain their proper situations (though each fluid individually is perpetually removed and renewed) for sixty, eighty, or a hundred years, or more, while *life* remains. So do the infinitely small vessels of an almost invisible insect, the fine and pellucid tubes of a plant, all hold their destined fluids, conveying or changing them according to fixed laws, but never permitting them to run into confusion, so long as the vital principle animates their various forms. But no sooner does *death* happen, than, without any alteration of structure, any apparent change in their *material* configuration, all is reversed. The eye loses its form and brightness; its membranes let go their contents, which mix in confusion, and thenceforth yield to the laws of chemistry alone. Just so it happens, sooner or later, to the other parts of the animal as well as vegetable frame. Chemical changes, putrefaction and destruction, immediately follow the total privation of life, the importance of which becomes instantly evident when it is no more. I humbly conceive therefore, that if the human understanding can in any case flatter itself with obtaining, in the natural world, a glimpse of the *immediate agency* of the Deity, it is in the contemplation of this *vital principle*, which seems independent of material organisation, and an impulse of his own divine energy.

CHAPTER II.

DEFINITION OF NATURAL HISTORY, AND PARTICULARLY BOTANY.—OF THE GENERAL TEXTURE OF PLANTS.

NATURAL History properly signifies that study by which we learn to distinguish from one another the natural bodies, whether Animal, Vegetable, or Mineral, around us; to discover as much as possible their nature and properties, and especially their natural dependence on each other in the general scale of beings. In a more extensive sense it may be said to teach their secondary properties, or the various uses to which they have been, or may be, converted, in the service of mankind or of other animals; inasmuch as an acquaintance with their natural qualities is our only sure guide to a knowledge of their artificial uses. But as this definition would include many arts and sciences, each of them sufficient to occupy any common mind, as Agriculture, Dietetics, Medicine, and many others, it is sufficient for a philosophical naturalist to be acquainted with the general principles upon which such arts and sciences are founded.

That part of Natural History which concerns plants is called Botany, from Βοτάνη, the Greek word for a herb or grass. It may be divided into three branches:

1st, The physiology of plants, or a knowledge of the structure and functions of their different parts; 2dly, The systematical arrangement and denomination of their several kinds; and 3dly, Their œconomical or medical properties. All these objects should be kept in view by an intelligent botanist. The two first are of essential service to each other, and the last is only to be pursued, with any certainty, by such as are versed in the other two. The present publication is intended to explain the fundamental principles of them all, with as much practical illustration as may be necessary for those who wish to become well acquainted with this delightful science. Botany has one advantage over many other useful and necessary studies, that even its first beginnings are pleasing and profitable, though pursued to ever so small an extent; the objects with which it is conversant are in themselves charming, and they become doubly so to those who contemplate them with the additional sense, as it were, which science gives; the pursuit of these objects is an exercise no less healthful to the body, than the observation of their laws and characters is to the mind.

In studying the functions of the Vegetable frame, we must constantly remember that it is not merely a collection of tubes or vessels holding different fluids, but that it is endowed with life, and consequently able not only to imbibe particular fluids, but to alter their nature according to certain laws, that is, to form peculiar secretions. This is the exclusive property of a living being. Animals secrete milk and fat from food which has no resemblance to those substances; so Vegetables secrete gum, sugar, and various resinous substances from the uniform juices of the earth, or perhaps from mere water and air. The most different and discordant fluids, separated only by the finest film or membrane, are, as we have already observed, kept perfectly distinct, while life remains; but no sooner does the vital principle depart, than secretion, as well as the due preservation of what has been secreted, are both at an end, and the principle of dissolution reigns absolute.

Before we can examine the physiology of vegetables, it is necessary to acquire some idea of their structure.

Much light has been thrown upon the general texture of Vegetables by the microscopic figures of Grew, Malpighi and others, repeated by Dr. Thornton in his Illustration of the Linnæan System, but more especially by the recent observations and highly magnified dissections of M. Mirbel. See his Table of Vegetable Anatomy in the work already mentioned. From preceeding writers we had learned the general tubular or vascular structure of the vegetable body, and the existence of some peculiar spirally-coated vessels in many plants. On these slender foundations physiologists have, at their pleasure, constructed various theories, relative to the motion of the sap, respiration and other functions, presumed to be analogous to those of animals. The anatomical observations of Mirbel go further than those of Grew, &c., and it is necessary to give a short account of his discoveries.

He finds, by the help of the highest magnifying powers, that the vegetable body is a continued mass of tubes and cells; the former extended indefinitely, the latter frequently and regularly interrupted by transverse partitions. These partitions being ranged alternately in the corresponding cells, and each cell increasing somewhat in diameter after its first formation, except where restrained by the transverse partitions, seems to account for their hexagonal figure*. See Tab. I. *f. a.* The membranous sides of all these cells and tubes are very thin, more or less transparent, often porous, variously perforated or torn. Of the tubes, some are without any lateral perforations, *f. b*, at least for a considerable extent; others pierced with holes ranged in a close spiral line, *f. c.*; in others several of these holes run together, as it were, into interrupted spiral clefts, *f. d;* and in some those clefts are continued, so that the whole tube, more or less, is cut into a spiral line, *f. e;* which, in some young branches and tender leaves, will unroll to a great extent, when they are gently torn asunder. The cellular texture especially is extended to every part of the vegetable body, even into the thin skin, called the cuticle, which covers every external part, and into the fine hairs or down which, in some instances, clothe the cuticle itself.

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* In microscopic figures they are generally drawn like circles intersecting each other.

Before we offer any thing upon the supposed functions of these different organs, we shall take a general view of the Vegetable body, beginning at the external part and proceeding inwards.

CHAPTER III.

OF THE CUTICLE OR EPIDERMIS.

Every part of a living plant is covered with a skin or membrane called the cuticle, which same denomination has been given by anatomists to the scarf skin that covers the animal body, protecting it from the injuries of the air, and allowing of due absorption and perspiration through its pores.

There is the most striking analogy between the animal and the vegetable cuticle. In the former, it varies in thickness from the exquisitely delicate film which covers the eye, to the hard skin of the hand or foot, or the far coarser covering of a Tortoise or Rhinoceros; in the latter it is equally delicate on the parts of a flower, and scarcely less hard on the leaves of the Pearly Aloe, or coarse on the trunk of a Plane tree. In the numerous layers of this membrane continually peeling off from the Birch, we see a resemblance to the scales which separate from the shell of a Tortoise. By maceration, boiling, or putrefaction, this part is separable from the plant as well as from the animal, being, if not absolutely incorruptible, much less prone to decomposition than the parts it covers. The vital principle, as far as we can judge, seems to be extinct in it.

The cuticle admits of the passage of fluids from within as well as from without, but in a due and definite proportion in every plant: consequently it must be porous; and the microscope shows, what reason would teach us to expect, that its pores are different in different kinds of plants. In very succulent plants, as Aloes, a leaf of which being cut off will lie for many weeks in the sun without drying entirely, and yet when partly dry will become plump again in a few hours if plunged into water, the cuticle must be very curiously constructed, so as to admit of ready absorption, and very tardy perspiration. Such plants are accordingly designed to inhabit hot sandy counties, where they are long exposed to a burning sun, with very rare supplies of rain.

This part allows also of the passage of air, as is proved by experiments on the functions of leaves. Light probably acts through it, as the cuticle is a colourless membrane. We know the effects of light to be very important in the vegetable œconomy.

But though this fine membrane admits extraneous substances, so as to have their due effect upon the vegetable constitution, according to fixed laws, it no less powerfully excludes all that would be injurious to the plant, either in kind or proportion. Against heat or cold it proves, in general, but a feeble defence; but when clothed with hair or wool, it becomes a very powerful one. Against the undue action of the atmosphere it is so important a guard, that, when any tender growing part is deprived of it, the greatest mischiefs ensue. It forms in the Vegetable, as well as the Animal, a fine but essential barrier between life and destruction.

Some have imagined that the cuticle gave form to the vegetable body, because it sometimes being over tight causes contractions on the stem of a tree, as in the plum or cherry, and because it is found to be cracked wherever an unnatural excrescence is produced on the bark. No doubt the cuticle is formed so as to accommodate itself only to the natural growth of the plant, not to any monstrosities, and those lumps cause it to burst; just as it happens to ripe fruits in very wet seasons. Their cuticle is constructed suitably to their usual size or plumpness, but not to any immoderate increase from too great absorption of wet. If the cuticle be removed from any part, no swelling follows, as it would if this membrane only kept the tree in shape.

The extension of the cuticle is astonishing, if we consider that it is formed, as Grew well observes, on the tenderest embryo, and only extended during the growth of the plant, and that it appears not to have any connexion with the vascular or living part of the vegetable body. But though so accommodating in those parts where it is wanted, on the old trunks of most trees it cracks in every direction, and in many is entirely obliterated, the old dead layers of their bark performing all the requisite offices of a cuticle.

M. Mirbel indeed, though he admits the importance of this part in the several ways above mentioned, contends that it is not a distinct organ like the cuticle of animals, but merely formed of the cellular parts of the plant dilated and multiplied, and changed by their new situation. This is very true; but upon the same principle the human cuticle can scarcely be called a distinct organ. Its texture is continually scaling off externally, and it is supplied with new layers from within. Just so does the cuticle of the Birch peel off in scales, separable, almost without end, into smaller ones.

Examples of different kinds of cuticle may be seen in the following plants,

On the Currant tree it is smooth, and scales off in large entire flakes, both from the young branches and old stem. The same may be observed in the Elder.

The fruit of the Peach and the leaf of the Mullein have a cuticle covered with dense and rather harsh wool, such as is found on many Mexican plants, and on more Cretan ones. The latter we know grow in open places under a burning sun.

The leaf of the White Willow is clothed with a fine silky or satiny cuticle.

The cuticle of the Betony, and of many other plants, is extended into rigid hairs or bristles, which in the Nettle are perforated and contain a venomous fluid.

On the fruit of the Plum, and on many leaves, we find a blueish dry powder covering the cuticle, which is a resinous exudation, and it is difficult to wet the surface of these plants. Rain trickles over them in large drops.

In the Cork tree, the Common Maple, and even the Dutch Elm, the cuticle is covered with a fungous substance most extraordinary in its nature, though familiar to us as cork.

In grasses and some other plants the ingenious Sir H. Davy has found a flinty substance in the cuticle.

What seems to be the cuticle on the trunk of the Plane, the Fir, and a kind of Willow called *Salix triandra*, rather consists of scales of bark, which having performed their functions and become dead matter, are rejected by the increasing bark beneath them; and this accords with M. Mirbel's idea of the cuticle. The old layers of bark in the Chesnut, Oak, and many other trees, though not cast off, are of the same nature; and these under the microscope exhibit the same cellular texture as the real cuticle.

CHAPTER IV.

OF THE CELLULAR INTEGUMENT.

IMMEDIATELY under the Cuticle we find a succulent cellular substance, for the most part of a green colour, at least in the leaves and branches, which is called by Du Hamel the *Enveloppe cellulaire*, and by Mirbel the *Tissu herbacé*. This is in general the seat of colour, and in that respect analogous to the *rete mucosum*, or pulpy substance situated under the human cuticle, which is pale in the European, and black in the Negro; but we must carry the analogy no further, for these two parts perform no functions in common. Du Hamel supposed this pulp to form the cuticle; but this is improbable, as his experiments show, when that membrane is removed, that the Cellular Integument exfoliates, at least in trees, or is thrown off in consequence of the injury it has sustained, and a new cuticle, covering a new layer of the same succulent matter, is formed under the old one. Annual stems or branches have not the same power, any more than leaves.

But little attention has been paid to this organ till lately, though it is very universal, even, as Mirbel observes, in Mosses and Ferns. The same writer remarks that "leaves consist almost entirely of a plate of this "substance, covered on each side by the cuticle. The "stems and branches of both annual and perennial "plants are invested with it; but in woody parts it is "dried up and reproduced continually, such parts only "having that reproductive power. The old layers "remain, are pushed outward by the new ones, and "form at length the rugged dry dead covering of the "old trunks of trees."

When we come to consider the curious functions of leaves, we shall find this part to be of the very first importance. In it the principal changes operated upon the juices of plants by light and air, and the consequent elaboration of all their peculiar secretions, take place.

CHAPTER V.

OF THE BARK.

Under the Cellular Integument we find the Bark, consisting of but one layer in plants or branches only one year old, and often not distinguishable from the wood. In the older branches and trunks of trees, it consists of as many layers as they are years old, the innermost being called the *liber*; and it is in this layer only that the essential vital functions are carried on for the time being, after which it is pushed outwards with the Cellular Integument, and becomes like that a lifeless crust. These older layers, however, are for some time reservoirs of the peculiar secreted juices of the plant, which perhaps they may help to perfect.

In some roots the bark, though only of annual duration, is very thick; as in the Carrot, the red part of which is all bark. In the Parsnep, though not distinctly coloured, it is no less evident. In the Turnip it is much thinner, though equally distinct from the wood or body of the root.

The Bark contains a great number of woody fibres, running for the most part longitudinally, which give it tenacity, and in which it differs very essentially from the parts already described. These woody fibres when separated by maceration exhibit in general a kind of net-work, and in many instances great regularity and beauty of structure. In a family of plants to which the Mezereon belongs, the fibres of the inner bark have a beautiful white shining appearance like silk. In one of this tribe, a native of Jamaica, and called Lace Bark, that part may be separated by lateral extension into an elegant kind of lace.

In the old bark of the Fir tribe, on the contrary, nothing of this kind is discernible. The bark of the Cluster Pine, *Pinus Pinaster*, some inches in thickness, is separable into thin porous layers, each of them the production of one season, which do really seem to be, according to M. Mirbel's theory, hardened and dried Cellular Integument; but they are rather perhaps that vascular part of the Bark which once contained the secreted fluid, or turpentine, so abundant in this tree.

The bark of Oak trees twenty or thirty years old, if cut and long exposed to the weather, separates into many fine thin layers, of a similar, though less delicate, texture to the Lace Bark of Jamaica. All these layers, in a living state, are closely connected with each other by the cellular texture which pervades the vegetable body in general, as well as by transverse vessels necessary for the performance of several functions hereafter to be mentioned.

In the bark the peculiar virtues or qualities of particular plants chiefly reside, and more especially in several of its internal layers nearest to the wood. Here we find in appropriate vessels the resin of the Fir and Juniper, the astringent principle of the Oak and Willow, on which their tanning property depends, the fine and valuable bitter of the Peruvian Bark, and the exquisitely aromatic oil of the Cinnamon. The same secretions do indeed, more or less, pervade the wood and other parts of these plants, but usually in a less concentrated form.

When a portion of the bark of a tree is removed, the remainder has a power of extending itself laterally, though very gradually, till the wound is closed. This is accomplished by each new layer, added to the bark internally, spreading a little beyond the edge of the preceding layer. The operation of closing the wound goes on the more slowly, as the wood underneath, from exposure to the air, has become dead, and frequently rotten, proving an incumbrance, which though the living principle cannot in this instance free itself from, it has no power of turning to any good account. If, however, this dead wood be carefully removed, and the wound protected from the injuries of the atmosphere, the new bark is found to spread much more rapidly; and as every new layer of bark forms, as will be proved in the next chapter, a new layer of wood, the whole cavity, whatever it may be, is in process of time filled up.

This operation of Nature was turned to great advantage by the late Mr. Forsyth of Kensington gardens, the history of whose experiments is before the public. Under his management many timber trees, become entirely hollow, were filled with new wood, and made to produce fresh and vigorous branches; and pear-trees, planted in the time of King William, and become so decayed and knotty as to bear no fruit worth gathering, were by gradual paring away of the old wood and bark, and the application of a composition judiciously contrived to stick close and keep out air and wet, restored to such health and strength as to cover the garden walls with new branches bearing a profusion of fine fruit. These experiments have passed under my own actual observation, and I am happy to bear testimony to the merits of a real lover of useful science, and one of the most honest and disinterested men I ever knew.

CHAPTER VI.

OF THE WOOD.

When the bark is removed, we come to the substance of the wood, which makes the principal bulk of the trunk or branch of a tree or shrub. When cut across, it is found to consist of numerous concentric layers, very distinct in the Fir, and other European trees in general. Each of these circular layers is externally most hard and solid. They differ however among themselves in this respect, as well as in their breadth on the whole. It often happens that all the layers are broadest towards one side of the tree, so that their common centre is thrown very much out of the actual centre of the trunk.

The wood owes its strength and tenacity to innumerable woody fibres, and consists of various vessels running for the most part longitudinally; some having a spiral coat, others not. Of these vessels, some in their youngest state convey the sap from the root to the extremities of the branches and leaves; others contain the various peculiar or secreted juices; others perhaps contain air. The whole are joined together by the cellular substance already described.

Linnæus and most writers believe that one of the abovementioned circular layers of wood is formed every year, the hard external part being caused by the cold of winter; consequently, that the exact age of a sound tree when felled may be known by counting these rings. It has even been asserted that the date of peculiarly severe winters may be found in the harder more condensed rings formed at those periods; and moreover, that the north side of a tree may always be known by the narrowness and density of the rings on that side. All this is controverted by Mirbel, chiefly on the authority of Du Hamel, who nevertheless scarcely says enough to invalidate the ancient opinion on the whole. It is very true that there may be occasional interruptions in the formation of the wood, from cold or fickle seasons, and that in some trees the thin intermediate layers, hardly discernible in general, which unite to form the principal or annual ones, may, from such fluctuation of seasons, become more distinct than is natural to them. Such intermediate layers are even found more numerous in some trees of the same species and age than in others. But as there is always a most material difference between summer and winter, so I believe will there always be a clear distinction between the annual rings of such trees as show them at all. Trees of hot countries indeed, as Mahogany, and evergreens in general, have them but indistinctly marked; yet even in these they are to be seen. With regard to their greater compactness on the north side of a tree, Du Hamel justly explodes this idea. In fact, there is most wood formed, and consequently these circles are broadest, on the side most favourable to vegetation, and where there are most branches and leaves. This in a solitary tree is generally towards the south; but it is easy to perceive the occasional variations which must arise from local exposure, soil, moisture, and other causes.

In some trees, a number of the outermost rings differ greatly in colour from the innermost, and are called by workmen the sap. In the Laburnum, the former are yellow, the latter brown. In the Oak and many other trees a similar difference, though less striking, is perceptible, and in most the external rings are much less firm, compact, and durable than the rest, retaining more vital principle, and more of the peculiar juices of the plant. Such rings are all comprehended by Du Hamel under the name of *Aubier*, alburnum; and he rightly observes that this difference often extends to a greater number of rings on one side of a tree than on another. It seems that the more vigour there is in a tree, or side of a tree, the sooner is its alburnum made perfect wood. By this term, however, is properly understood only the layer of new unhardened wood of the present year. When the word alburnum is used in the following pages, it applies to this part only.

Physiologists have long differed and do still differ about the origin of the wood. Malpighi and Grew thought it was formed by the bark, and the best observations have confirmed their opinion. Hales supposed the wood added a new layer to itself externally every year. Linnæus had a peculiar notion, that a new layer of wood was secreted annually from the pith, and added internally to the former ones. Truth obliges us to confess that the latter theory is most devoid of any kind of proof or probability.

Du Hamel, by many experiments, proved the wood to be secreted or deposited from the innermost part of the bark or *liber*. He introduçed plates of tinfoil under the barks of growing trees, carefully binding up their wounds, and, after some years, on cutting them across, he found the layers of new wood on the outside of the tin. His original specimens I have examined in the public museum at Paris.

Dr. Hope, the late worthy Professor of Botany at Edinburgh, instituted an experiment, if possible more decisive, upon a branch of Willow three or four years old. The bark was carefully cut through longitudinally on one side for the length of several inches, so that it might be slipped aside from the wood in the form of a hollow cylinder, the two ends being undisturbed. The edges of the bark were then united as carefully as possible, the wood covered from the air, and the whole bound up to secure it from external injury. After a few years, the branch was cut through transversely. The cylinder of bark was found lined with layers of new wood, whose number added to those in the wood from which it had been stripped, made up the number of rings in the branch above and below the experiment. For an account of this experiment I am indebted to Dr. Thomas Hope, the present Chemical Professor at Edinburgh.

Du Hamel engrafted a portion of the bark of a Peach-tree upon a Plum. After some time he found a layer of new wood under the engrafted bark, white like that of the Peach, and evidently different from the red wood of the Plum. Moreover, in this and other experiments made with the same intention, he found the layers of new wood always connected with the bark, and not united to the old wood. See his *Physique des Arbres, vol.* 2. 29, &c. It deserves also to be mentioned, that by performing this experiment of engrafting a portion of bark at different periods through the spring and summer, the same accurate observer found a great difference in the thickness of the layer of new wood produced under it, which was always less in proportion as the operation was performed later in the season.

That the bark or *liber* produces wood seems therefore proved beyond dispute, but some experiments persuaded Du Hamel that in certain circumstances the wood was capable of producing a new bark. This never happened in any case but when the whole trunk of a tree was stripped of its bark. A Cherry-tree treated in this manner exuded from the whole surface of its wood in little points a gelatinous matter, which gradually extended over the whole and became a new bark, under which a layer of new wood was speedily formed. Hence Mirbel concludes, *vol.* 1. 176, that the alburnum and the wood are really the origin of the new layers of wood, by producing first this gelatinous substance, or matter of organization, which he and Du Hamel call *cambium*, and which Mirbel supposes to produce the *liber* or young bark, and at the same time, by a peculiar arrangement of the vascular parts, the *alburnum* or new wood. His opinion is strengthened by the observation of a tribe of plants to be explained hereafter, Palms, Grasses, &c. in which there is no real bark, and in which he finds that the woody fibres do actually produce the *cambium*. Dr. Hope's experiment will scarcely invalidate this opinion, because it may be said the *cambium* had already in that case formed the *liber*.

This matter will be better understood when we come to speak of Mr. Knight's experiments on the course of the sap.

CHAPTER VII.

OF THE MEDULLA OR PITH.

THE centre or heart of the vegetable body, within the wood, contains the *Medulla* or Pith. This, in parts most endowed with life, as roots, and young growing stems or branches, is a tolerably firm juicy substance, of an uniform texture, and commonly a pale green or yellowish colour. Such is its appearance in the young shoots of Elder in the spring; but in the very same branches, fully grown, the pith becomes dry, snow-white, highly cellular, and extremely light, capable of being compressed to almost nothing. So it appears likewise in the common Red or White Currant, and numerous other plants. In many annual stems the pith, abundant and very juicy while they are growing, becomes little more than a web, lining the hollow of the complete stem, as in some Thistles. Many grasses and umbelliferous plants, as *Conium maculatum* or Hemlock, have always hollow stems, lined only with a thin smooth coating of pith, exquisitely delicate and brilliant in its appearance.

Concerning the nature and functions of this part various opinions have been held.

Du Hamel considered it as merely cellular substance, connected with what is diffused through the whole plant, combining its various parts, but not performing any remarkable office in the vegetable œconomy.

Linnæus, on the contrary, thought it the seat of life and source of vegetation; that its vigour was the main cause of the propulsion of the branches, and that the seeds were more especially formed from it. This latter hypothesis is not better founded than his idea, already mentioned, of the pith adding new layers internally to the wood. In fact the pith is soon obliterated in the trunks of many trees, which nevertheless keep increasing, for a long series of years, by layers of wood added every year from the bark, even after the heart of the tree is become hollow from decay.

Some considerations have led me to hold a medium opinion between these two extremes. There is, in certain respects, an analogy between the *medulla* of plants and the nervous system of animals. It is no less assiduously protected than the spinal marrow or principal nerve. It is branched off and diffused through the plant, as nerves are through the animal. Hence it is not absurd to presume that it may, in like manner, give life and vigour to the whole, though by no means, any more than nerves, the organ or source of nourishment. It is certainly most vigorous and abundant in young and growing branches, and must be supposed to be subservient, in some way or other, to their increase. Mr. Lindsay of Jamaica, in a paper read long ago to the Royal Society, but not published, thought he demonstrated the *medulla* in the leaf-stalk of the

Mimosa pudica, or Sensitive Plant, to be the seat of irritability, nor can I see any thing to invalidate this opinion.

Mr. Knight, in the Philosophical Transactions for 1801, *p*. 348, supposes the *medulla* may be a reservoir of moisture, to supply the leaves whenever an excess of perspiration renders such assistance necessary, and he has actually traced a direct communication by vessels between it and the leaf. "Plants," says that ingenious writer, "seem to require some "such reservoir; for their young leaves are exces-"sively tender, and they perspire much, and cannot, "like animals, fly to the shade and the brook."

This idea of Mr. Knight's may derive considerable support from the consideration of bulbous-rooted grasses. The common Cats-tail, *Phleum pratense*, *Engl. Bot. t.* 1076, when growing in pastures that are uniformly moist, has a fibrous root; but in dry situations, or such as are only occasionally wet, it acquires a bulbous one, whose inner substance is moist and fleshy, like the pith of young branches of trees. This is evidently a provision of Nature to guard the plant against too sudden a privation of moisture from the soil.

But, on the other hand, all the moisture in the *medulla* of a whole branch is, in some cases, too little to supply one hour's perspiration of a single leaf. Neither can I find that the moisture of the *medulla* varies, let the leaves be ever so flaccid. I cannot but incline therefore to the opinion that the *medulla* is rather a reservoir of vital energy, even in these bulbous grasses.

Mr. Knight has shown that the part in question may be removed without any great injury to a branch, or at least without immediate injury; but I have had no opportunity of making any experiments on this particular subject.

CHAPTER VIII.

OF THE SAP-VESSELS, AND COURSE OF THE SAP; WITH MR. KNIGHT'S THEORY OF VEGETATION.

Much contrariety of opinion has existed among physiologists concerning the vascular system of plants, and the nature of the propulsion of the sap through their stems and branches. Indeed it is a subject upon which, till lately, very erroneous ideas have prevailed.

That the whole vegetable body is an assemblage of tubes and vessels is evident to the most careless observer; and those who are conversant with the microscope, and books relating to it, have frequent opportunities of observing how curiously these vessels are arranged, and how different species of plants, especially trees, differ from each other in the structure and disposition of them. Such observations, however, if pursued no further, lead but a little way towards a knowledge of the wonderful physiology of vegetables.

In our 2d chapter, mention is made of the general cellular and vascular texture of plants; we must now be a little more particular in our inquiries.

That plants contain various substances, as sugar, gum, acids, odoriferous fluids and others, to which their various flavours and qualities are owing, is familiar to every one; and a little reflection will satisfy us that such substances must each be lodged in proper cells and vessels to be kept distinct from each other. They are extracted, or secreted, from the common juice of the plant, and called its peculiar or secreted fluids. Various experiments and observations, to be hereafter enlarged upon, prove also that air exists in the vegetable body, and must likewise be contained in appropriate vessels. Besides these, we know that plants are nourished and invigorated by water, which they readily absorb, and which is quickly conveyed through their stalks and leaves, no doubt by tubes or vessels on purpose. Finally, it is observable that all plants, as far as any experiment has been made, contain a common fluid, which at certain seasons of the year is to be obtained in great quantity, as from vine branches by wounding them in the spring before the leaves appear, and this is properly called the sap. It is really the blood of the plant, by which its whole body is nourished, and from which the peculiar secretions are made.

The great difficulty has been to ascertain the vessels in which the sap runs. Two of the most distinguished inquirers into the subject, Malpighi and Grew, believed the woody fibres, which make so large a part of the vegetable body, and give it consistence and strength, to be the sap-vessels, analogous to the blood-vessels of animals, and their opinion was adopted by Du Hamel. In support of this theory it was justly observed that these fibres are very numerous and strong, running longitudinally, often situated with great uniformity (an argument for their great importance), and found in all parts of a plant, although in some they are so delicate as to be scarcely discernible. But philosophers sought in vain for any perforation, any thing like a tubular structure, in the woody fibres to countenance this hypothesis, they being divisible almost without end, like the muscular fibre. This difficulty was overlooked, because of the necessity of believing the existence of sap-vessels somewhere; for it is evident that the nutrimental fluids of a plant must be carried with force towards certain parts and in certain directions, and that this can be accomplished by regular vessels only, not, as Tournefort supposed, by capillary attraction through a simple spongy or cottony substance.

I received the first hint of what I now believe to be the true sap-vessels from the 2d section of Dr. Darwin's *Phytologia*, where it is suggested that what have been taken for air-vessels are really absorbents destined to nourish the plant, or, in other words, sap-vessels. The same idea has been adopted, confirmed by experiments, and carried to much greater perfection by Mr. Knight, whose papers in the Philosophical Transactions for 1801, 1804 and 1805 throw the most brilliant light upon it, and, I think, establish no less than an entirely new theory of vegetation, by which the real use and functions of the principal organs of plants are now for the first time satisfactorily explained.

In a young branch of a tree or shrub, or in the stem of an herbaceous plant, are found, ranged round the centre or pith, a number of longitudinal tubes or vessels, of a much more firm texture than the adjacent parts, and when examined minutely, these vessels often appear to be constructed with a spiral coat. This may be seen in the young twigs and leaf stalks of Elder, Syringa, and many other shrubs, as well as in numerous herbaceous plants, as the Peony, and more especially many of the Lily tribe. If a branch or stalk of any of these plants be partly cut through or gently broken, and its divided portions slowly drawn asunder, the spiral coats of their vessels will unroll, exhibiting a curious spectacle even to the naked eye. In other cases, though the spiral structure exists, its convolutions are scarcely separable at all, or so indeterminate as to be only marked by an interrupted line of perforations or slits, as shown by M. Mirbel. Indeed the very same branches which exhibit these spiral vessels when young, show no signs of them at a more advanced period of growth, when their parts are become more woody, firm, and rigid. No such spiral-coated vessels have been detected in the bark at any period of its growth.

Malpighi asserts that these vessels are always found to contain air only, no other fluid; while Grew reports that he sometimes met with a quantity of moisture in them. Both judged them to be air-vessels, or, as it were, the lungs of plants, communicating, as these philosophers presumed, with certain vessels of the leaves and flowers, of an oval or globular form, but destitute of a spiral coat. These latter do really contain air, but it rather appears from experiment that they have no direct communication with the former. Thus the tubes in question have always been called air-vessels, till Darwin suggested their real nature and use*. He is perhaps too decisive when he asserts that none of them are air-vessels *because* they exist in the root, which is not exposed to the atmosphere. We know that air acts upon the plant under ground, because seeds will not vegetate in earth under the exhausted receiver of an air-pump. *Phil. Trans. No.* 23. I do not however mean to contend that any of these spiral vessels are air-vessels, nor do I see reason to believe that plants have any system of longitudinal air-vessels at all, though they must be presumed to abound in such as are transverse or horizontal.

Dr. Darwin and Mr. Knight have, by the most simple and satisfactory experiment, proved these spiral vessels to be the channel through which the sap is conveyed. The former placed leafy twigs of a common Fig-tree about an inch deep in a decoction of madder, and others in one of logwood. After some hours, on cutting the branches across, the coloured liquors were found to have ascended into each branch by these vessels, which exhibited a circle of red dots round the pith, surrounded by an external circle of vessels containing the white milky juice, or secreted fluid, so remarkable in the fig-tree. Mr. Knight, in a similar manner, inserted the lower ends of some cuttings of the Apple-tree and Horse-chesnut into an infusion of the skins of a very black grape in water, an excellent liquor for the purpose. The result was similar. But Mr. Knight pursued his observations much further than Dr. Darwin had done; for he traced the coloured liquid even into the leaves, "but it had neither coloured the bark nor the sap between it and the wood; and the *medulla* was not affected, or at most was very slightly tinged at its edges." *Phil. Trans. for* 1801, *p.* 335.

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* Du Hamel, indeed, once suspected that they contained "highly rarefied sap," but did not pursue the idea.

The result of all Mr. Knight's experiments and remarks seems to be, that the fluids destined to nourish a plant, being absorbed by the root and become sap, are carried up into the leaves by these vessels, called by him *central* vessels, from their situation near the pith. A particular set of them, appropriated to each leaf, branches off, a few inches below the leaf to which they belong, from the main channels that pass along the alburnum, and extend from the fibres of the root to the extremity of each annual shoot of the plant. As they approach the leaf to which they are destined, the central vessels become more numerous, or subdivided. "To these vessels," says Mr. Knight, "the spiral tubes are every where appendages." *p.* 336. By this expression, and by a passage in the following page *, 337, this writer might seem to consider the spiral line, which forms the coats of these vessels, as itself a pervious tube, or else that he was speaking of other tubes with a spiral coat, companions of the sap-vessels; but the plate which accompanies his dissertation, and the perspicuous mode in which he treats the subject throughout, prevent our mistaking him on the last point. In order to conceive how the sap can be so powerfully conveyed as it is through the vessels in which it flows, from the root of a tall tree to its highest branches, we must take into consideration the action of heat. We all know that this is necessary to the growth and health of plants; and that it requires to be nicely adjusted in degree, in order to suit the constitutions of different tribes of plants destined for different parts of the globe. It cannot but act as a stimulus to the living principle, and is one of the most powerful agents of Nature upon the vegetable as well as animal constitution. Besides this, however, various mechanical causes may be supposed to have their effect; as the frequently spiral or screw-like form of the vessels, in some of which, when separated from the plant, Malpighi tells

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* "The whole of the fluid, which passes from the wood to the leaf, seems to me evidently to be conveyed through a single kind of vessel; for the spiral tubes will neither carry coloured infusions, nor in the smallest degree retard the withering of the leaf, when the central vessels are divided." *Knight.*

us he once saw a very beautiful undulating motion that appeared spontaneous. This indeed has not been seen by any other person, nor can it be supposed that parts so delicate can, in general, be removed from their natural situation, without the destruction of that fine irritability on which such a motion must depend. We may also take into consideration the agitation of the vegetable body by winds, which is known by experience to be so wholesome to it*, and must serve powerfully to propel the fluids of lofty trees; the passage, and evolution perhaps, of air in other parts or vessels, surrounding and compressing these; and lastly the action, so ingeniously supposed by Mr. Knight, of those thin shining plates called the *silver grain*, visible in oak wood, which pressing upon the sap-vessels, and being apparently susceptible of quick changes from variations in heat or other causes, may have a powerful effect. "Their restless temper," says Mr. Knight, "after the tree has ceased to live, inclines me to believe that they are not made to be idle whilst it continues alive." *Phil. Trans. for* 1801, *p.* 344. These plates are presumed by the author just quoted to be peculiarly useful in assisting the ascent of the sap through the alburnum of the trunk or chief branches, where indeed the spiral coats of the vessels are either wanting, or less elastic than in the leaf-stalks and summits of the more tender shoots.

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* See Mr. Knight's experiments in confirmation of this in the *Phil. Trans. for* 1803, *p.* 280.

However its conveyance may be accomplished, it is certain that the sap does reach the parts above mentioned, and there can surely be now as little doubt of the vessels in which it runs. That these vessels have been thought to contain air only, is well accounted for by Dr. Darwin, on the principle of their not collapsing when emptied of their sap; which is owing to their rigidity, and the elastic nature of their coats. When a portion of a stem or branch is cut off, the sap soon exhales from it, or rather is pushed out by the action of the vessels themselves: hence they are found empty; and for the same reason the arteries of animals were formerly thought to contain air only. When the sap-vessels have parted with their natural contents, air and even quicksilver will readily pass through them, as is shown by various experiments. Arguments in support of any theory must be very cautiously deduced from such experiments, or from any other observations not made on vegetables in their most natural state and condition; and, above all, that great agent the vital principle must always be kept in view, in preference to mere mechanical considerations.

These to which I give the common name of sap-vessels, comprehending the common tubes of the alburnum, and the central vessels, of Mr. Knight, may be considered as analogous to the arteries of animals; or rather they are the stomach, lacteals and arteries all in one, for I conceive it to be a great error in Dr. Darwin to call by this name the vessels which contain the peculiar secretions of the plant*. These sap-vessels, no doubt, absorb the nutritious fluids afforded by the soil, in which possibly, as they pass through the root, some change analogous to digestion may take place; for there is evidently a great difference, in many cases, between the fluids of the root, at least the secreted ones, and those of the rest of the plant; and this leads us to presume that some considerable alteration may be wrought in the sap in its course through that important organ. The stem, which it next enters, is by no means an essential part, for we see many plants whose leaves and flowers grow directly from the root.

Part of the sap is conveyed into the flowers and fruit, where various fine and essential secretions are made from it, of which we shall speak hereafter. By far the greater portion of the sap is carried into the leaves, of the great importance and utility of which to the plant itself Mr. Knight's theory is the only one that gives us any adequate or satisfactory notion. In those organs the sap is exposed to the action of light, air and moisture, three powerful agents, by which it is enabled to form various secretions, at the same time that much superfluous matter passes off by perspiration. These secretions not only give peculiar flavours and qualities to the leaf itself, but are returned by another set of vessels, as Mr. Knight has demonstrated, into the new layer of bark, which they nourish and bring to perfection, and which they enable in its turn to secrete matter for a new layer of alburnum the ensuing year. It is presumed that one set of the returning vessels of trees may probably be more particularly destined to this latter office, and another to the secretion of peculiar fluids in the bark. See *Phil. Trans. for* 1801, *p.* 337. In the bark principally, if I mistake not, the peculiar secretions of the plant are perfected, as gum, resin, &c., each undoubtedly in an appropriate set of vessels. From what has just been said of the office of leaves, we readily perceive why all the part of a branch above a leaf or leaf-bud dies when cut, as each portion receives nourishment, and the means of increase, from the leaf above it.

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* *Phytologia, sect.* 2.

By the above view of the vegetable œconomy, it appears that the vascular system of plants is strictly annual. This, of course, is admitted in herbaceous plants, the existence of whose stems, and often of the whole individual, is limited to one season; but it is no less true with regard to trees. The layer of alburnum on the one hand is added to the wood, and the *liber*, or inner layer of the bark, is on the other annexed to the layers formed in preceding seasons, and neither has any share in the process of vegetation for the year ensuing. Still, as they continue for a long time to be living bodies, and help to perfect, if not to form, secretions, they must receive some portion of nourishment from those more active parts which have taken up their late functions.

There is a tribe of plants called *monocotyledones*, having only one lobe to the seed*, whose growth requires particular mention. To these belongs the natural order of Palms, which being the most lofty, and, in some instances, the most long-lived of plants, have justly acquired the name of trees. Yet, paradoxical as it may seem, they are rather perennial herbaceous plants, having nothing in common with the growth of trees in general. Their nature has been learnedly explained by M. Desfontaines, a celebrated French botanist, and by M. Mirbel in his *Traité d'Anatomie et de Physiologie Végétales, vol.* 1. *p.* 209, and Linnæus has long ago made remarks to the same purpose. The Palms are formed of successive circular crowns of leaves, which spring directly from the root. These leaves and their footstalks are furnished with bundles of large sap-vessels and returning vessels, like the leaves of our trees. When one circle of them has performed its office, another is formed within it, which being confined below, necessarily rises a little above the former. Thus successive circles grow one above the other, by which the vertical increase of the plant is almost without end. Each circle of leaves is independent of its predecessor, and has its own clusters of vessels, so that there can be no aggregation of woody circles; and yet in some of this tribe the spurious kind of stem, formed in the manner just described, when cut across shows something of a circular arrangement of fibres, arising from the original disposition of the leaves. The common orange lily, *Lilium bulbiferum*, *Curt. Mag. t.* 36, and white lily, *L. candidum*, *t.* 278, which belong to the same natural family called *monocotyledones*, serve to elucidate this subject. Their stems, though of only annual duration, are formed nearly on the same principle as that of a Palm, and are really congeries of leaves rising one above another, and united by their bases into an apparent stem. In these the spiral coats of the sap-vessels are very easily discernible.

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* Or rather no true cotyledon at all.

To conclude this subject of the propulsion of the sap, it is necessary to say a few words on the power which the vessels of plants are reported to possess of conveying their appropriate fluids equally well in either direction; or, in other words, that it is indifferent whether a cutting of any kind be planted with its upper or lower end in the ground. On this subject also Mr. Knight has afforded us new information, by observing that, in cuttings so treated, the returning vessels retain so much of their original nature as to deposit new wood *above* the leaf-buds; that is, in the part of the cutting which, if planted in its natural position, would have been below them. It appears, however, that the sap-vessels must absorb and transmit their sap in a direction contrary to what is natural; and it is highly probable, that after some revolving seasons new returning vessels would be formed in that part of the stem which is now below the buds. I presume there can be no doubt that successive new branches would deposit their wood in the usual position. It is nevertheless by no means common for such inverted cuttings to succeed at all. An experiment to a similar purpose is recorded by Dr. Hales, *Vegetable Staticks*, *p.* 132, *t.* 11, of engrafting together three trees standing in a row, and then cutting off the communication between the central one and the earth, so that it became suspended in the air, and was nourished merely through its lateral branches. The same experiment was successfully practised by the late Dr. Hope at Edinburgh upon three Willows, and in the years 1781, 2, and 3, I repeatedly witnessed their health and vigour. It was observed that the central tree was several days later in coming into leaf than its supporters, but I know not that any other difference was to be perceived between them. The tree which wanted the support of the ground was, some years after, blown down, so that we have now no opportunity of examining the course of its vessels, or the mode in which successive layers of wood were deposited in its branches; but the experiment is easily repeated.

In the weeping variety of the Common Ash, now so frequent in gardens, the branches are completely inverted as to position, yet the returning fluids appear to run exactly in their natural direction, depositing new wood, as they are situated *above* the buds or leaves; and if the end of any branch be cut, all beyond (or *below*) the next bud dies; so that in this case gravitation, to which Mr. Knight attributes considerable power over the returning fluids, *Phil. Trans. for* 1804, does not counteract the ordinary course of nature.

CHAPTER IX.

OF THE SAP, AND INSENSIBLE PERSPIRATION.

THE sap of trees, as has been mentioned in the last chapter, may be obtained by wounding a stem or branch in spring, just before the buds open, or in the end of autumn, though less copiously, after a slight frost; yet not during the frost. In the Palm-trees of hot countries, it is said to flow from a wound at any time of the year. It has always been observed to flow from the young wood or alburnum of our trees, not from the bark; which agrees with Mr. Knight's theory.

A common branch of the Vine cut through will yield about a pint of this fluid in the course of twenty-four hours. The Birch, *Betula alba*, affords plenty of sap; some other trees yield but a small quantity. It flows equally upward and downward from a wound, at least proportionably to the quantity of stem or branch in either direction to supply it. Some authors have asserted that in the heat of the day it flows most from the lower part of a wound, and in the cool of the evening from the upper; hence they concluded it was ascending during the first period, and descending in the latter. If the fact be true, some other solution must be sought; nor would it be difficult to invent a theory upon this subject: but we rather prefer the investigation of truth on more solid foundations.

This great motion, called the *flowing*, of the sap, which is to be detected principally in the spring, and slightly in the autumn, is therefore totally distinct from that constant propulsion of it going on in every growing plant, about which so much has been said in the preceding chapter, and which is proved by taking an entire herb of any kind that has been gathered and suffered to begin to fade, and immersing its root in water. By absorption through the sap-vessels it presently revives, for those vessels require a constant supply from the root.

This *flowing* of the sap has been thought to demonstrate a circulation, because, there being no leaves to carry it off by perspiration, it is evident that, if it were at these periods running up the sap-vessels with such velocity, it must run down again by other channels. As soon as the leaves expand, its motion is no longer to be detected. The effusion of sap from plants, when cut or wounded, is, during the greater part of the year, comparatively very small. Their secreted fluids run much more abundantly.

I conceive therefore that this *flowing* is nothing more than a facility in the sap to run, owing to the peculiar irritability of the vegetable body at the times above mentioned; and that it runs only when a wound is made, being naturally at rest till the leaves open, and admit of its proper and regular conveyance. Accordingingly, ligatures made at this period, which show so plainly the course of the blood in an animal body, have never been found to throw any light upon the vegetable circulation. This great facility in the sap to run is the first step towards the revival of vegetation from the torpor of winter; and its exciting cause is heat, most unquestionably by the action of the latter on the vital principle, and scarcely by any mechanical operation, or expansive power upon the fluids. The effect of heat is in proportion to the degree of cold to which the plant has been accustomed. In forced plants the irritability, or, to use the words of a late ingenious author*, who has applied this principle very happily to the elucidation of the animal œeonomy, *excitability*, is exhausted, as Mr. Knight well remarks, and they require a stronger stimulus to grow with vigour. See *p.* 69. Hence vegetation goes on better in the increasing heat of spring than in the decreasing heat of autumn. And here I cannot but offer, by way of illustration, a remark on the theory advanced by La Cepede, the able continuator of Buffon, relative to serpents. That ingenious writer mentions, very truly, that these reptiles awake from their torpid state in the spring, while a much less degree of heat exists in the atmosphere than is perceptible in the autumn, when, seemingly from the increasing cold, they become benumbed; and he explains it by supposing a greater degree of electricity in the air at the former season. Dr. Brown's hypothesis, of their irritability being as it were accumulated during winter, offers a much better solution, either with respect to the animal or vegetable constitution. For the same reason, it is necessary to apply warmth very slowly and carefully to persons frozen, or even chilled only, by a more than usual degree of cold, which renders them more susceptible of heat, and a temperate diet and very moderate stimulants are most safe and useful to the unexhausted constitutions of children. The same principle accounts for the occasional *flowing* of the sap in autumn after a slight frost. Such a premature cold increases the sensibility of the plant to any warmth that may follow, and produces, in a degree, the same state of its constitution as exists after the longer and severer cold of winter. Let me be allowed a further illustration from the animal kingdom. Every body conversant with labouring cattle must have observed how much sooner they are exhausted by the warm days of autumn, when the nights are cold, than in much hotter weather in summer, and this is surely from the same cause as the autumnal flowing of the vegetable sap.

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* Dr. John Brown, formerly of Edinburgh. See the 14th Section of Dr. Darwin's *Phytologia* on this subject.

The sap, or lymph, of most plants when collected in the spring as above mentioned, appears to the sight and taste little else than water, but it soon undergoes fermentation and putrefaction. Even that of the Vine is scarcely acid, though it can hardly be obtained without some of the secreted juices, which in that plant are extremely acid and astringent. The sap of the Sugar

Maple, *Acer saccharinum*, has no taste, though according to Du Hamel every 200 ℔. of it will afford 10 ℔. of sugar. Probably, as he remarks, it is not collected without an admixture of secreted fluids.

As soon as the leaves expand, insensible perspiration takes place very copiously, chiefly from those organs, but also in some degree from the bark of the young stem or branches. The liquor perspired becomes sensible to us by being collected from a branch introduced into any sufficiently capacious glass vessel, and proves, for the most part, a clear watery liquor like the sap, and subject to similar chemical changes. It is observed to be uniform in all plants, or nearly so, as well as the sap, except where odorous secretions transude along with it. Still there must be a very essential difference between the original sap of any plant and its perspiration, the latter no longer retaining the rudiments of those fine secretions which are elaborated from the former; but that difference eludes our senses as well as our chemistry. The perspiration of some plants is prodigiously great. The large Annual Sunflower, *Helianthus annuus, Gerarde Emac.* 751. *f.* 1, according to Dr. Hales, perspires about 17 times as fast as the ordinary insensible perspiration of the human skin. But of all plants upon record I think the Cornelian Cherry, *Cornus mascula*, is most excessive in this respect. The quantity of fluid which evaporates from its leaves in the course of twenty-four hours, is said to be nearly equal to twice the weight of the whole shrub. *Du Hamel Phys. des Arbres*, *v.* 1. 145.

CHAPTER X.

OF THE SECRETED FLUIDS OF PLANTS. GRAFTING. HEAT OF THE VEGETABLE BODY.

THE sap in its passage through the leaves and bark becomes quite a new fluid, possessing the peculiar flavour and qualities of the plant, and not only yielding woody matter for the increase of the vegetable body, but furnishing various secreted substances, more or less numerous and different among themselves. These accordingly are chiefly found in the bark; and the vessels containing them often prove upon dissection very large and conspicuous, as the turpentine-cells of the Fir tribe. In herbaceous plants, whose stems are only of annual duration, the perennial roots frequently contain these fluids in the most perfect state, nor are they, in such, confined to the bark, but deposited throughout the substance or wood of the root, as in Rhubarb, *Rheum palmatum, Linn. fil. Fasc. t.* 4, and Gentian, *Gentiana lutea* and *purpurea, Ger. Emac.* 432, *f.* 1, 2. In the wood of the Fir indeed copious depositions of turpentine are made, and in that of every tree more or less of a gummy, resinous, or saccharine matter is found. Such must be formed by branches of those returning vessels that deposit the new alburnum. These juices appear to be matured, or brought to greater perfection, in layers of wood or bark that have no longer any principal share in the circulation of the sap.

The most distinct secretions of vegetables require to be enumerated under several different heads.

Gum or mucilage, a viscid substance of little flavour or smell, soluble in water, is very general. When superabundant it exudes from many trees in the form of large drops or lumps, as in Plum, Cherry, and Peach-trees, and different species of *Mimosa* or Sensitive plants, one of which yields the Gum Arabic, others the Gum Senegal, &c.

Resin is a substance soluble in spirits, and much more various in different plants than the preceding, as the Turpentine of the Fir and Juniper, the Red Gum of New South Wales, produced by one or more species of *Eucalyptus*, *Bot. of N. Holl. t.* 13, and the fragrant Yellow Gum of the same country, see *White's Voyage*, 235, which exudes spontaneously from the *Xanthorrhœa Hastile.* Most vegetable exudations partake of a nature between these two, being partly soluble in water, partly in spirits, and are therefore called Gum-resins. The milky juice of the Fig, Spurge, &c., which Dr. Darwin has shown, and which every body may see, to be quite distinct from the sap, is, like animal milk, an *emulsion*, or combination of a watery fluid with oil or resin. Accordingly, when suffered to evaporate in the air, such fluids become resins or gum-resins, as the Gum *Euphorbium*. In the

Celandine, *Chelidonium majus*, *Engl. Bot. t.* 1581, and some plants allied to it, the emulsion is orange-coloured.

The more refined and volatile secretions of a resinous nature are called Essential Oils, and are often highly aromatic and odoriferous. One of the most exquisite of these is afforded by the Cinnamon bark. They exist in the highest perfection in the perfumed effluvia of flowers, some of which, capable of combination with spirituous fluids, are obtainable by distillation, as that of the Lavender and Rose; while the essential oil of the Jasmine is best procured by immersing the flowers in expressed oil, which imbibes and retains their fragrance. Such Expressed or Gross Oils, as they are called, to distinguish them from essential oils obtained by distillation, are chiefly found in the seeds of plants. In the pulp of the Olive indeed they occur in the form of an emulsion, mixed with watery and bitter fluids, from which the oil easily separates by its superior lightness. These expressed oils are not soluble in spirits or water, though by certain intermediate substances they may be rendered capable of uniting with both.

The Bitter secretion of many plants does not seem exactly to accord with any of the foregoing. Some facts would seem to prove it of a resinous nature, but it is often perfectly soluble in water. Remarkable instances of this secretion are in the *Cinchona officinalis* or Peruvian bark, *Lambert Cinchona, t.* 1, and every species, more or less, of Gentian.

Acid secretions are well known to be very general in plants. Formerly one uniform vegetable or acetous acid was supposed common to all plants; but the refinements of modern chemistry have detected in some a peculiar kind, as the Oxalic acid, obtained from *Oxalis* or Wood Sorrel, and several others. The astringent principle should seem to be a sort of acid, of which there are many different forms or kinds, and among them the tanning principle of the Oak, Willow, &c.

On the other hand, two kinds of Alkali are furnished by Vegetables, of which the most general is the Vegetable Alkali, properly so called, known by the name of Salt of Tartar, or Salt of Wormwood, or more correctly by the Arabic term *Kali.* The Fossil Alkali, or *Soda*, is most remarkable in certain succulent plants that grow near the sea, belonging to the genera *Chenopodium*, *Salsola*, &c. When these plants are cultivated in a common soil, they secrete *Soda* as copiously, provided their health be good, as in their natural maritime places of growth.

Sugar, more or less pure, is very generally found in plants. It is not only the seasoning of most eatable fruits, but abounds in various roots, as the Carrot, Beet, and Parsnip, and in many plants of the grass or cane kind besides the famous Sugar Cane *Saccharum* *officinarum*. There is great reason to suppose Sugar not so properly an original secretion, as the result of a chemical change in secretions already formed, either of an acid or mucilaginous nature, or possibly a mixture of both. In ripening fruits this change is most striking, and takes place very speedily, seeming to be greatly promoted by heat and light. By the action of frost, as Dr. Darwin observes, a different change is wrought in the mucilage of the vegetable body, and it becomes starch.

A fine red liquor is afforded by some plants, as the Bloody Dock or *Rumex sanguineus*, *Engl. Bot. t.* 1533, the Red Cabbage and Red Beet, which appears only to mark a variety in all these plants, and not to constitute a specific difference. It is however perpetuated by seed.

It is curious to observe, not only the various secretions of different plants, or families of plants, by which they differ from each other in taste, smell, qualities and medical virtues, but also their great number, and striking difference, frequently in the same plant. Of this the Peach-tree offers a familiar example. The gum of this tree is mild and mucilaginous. The bark, leaves and flowers abound with a bitter secretion of a purgative and rather dangerous quality, than which nothing can be more distinct from the gum. The fruit is replete, not only with acid, mucilage and sugar, but with its own peculiar aromatic and highly volatile secretion, elaborated within itself, on which its fine flavour depends. How far are we still from understanding the whole anatomy of the vegetable body, which can create and keep separate such distinct and discordant substances!

Nothing is more astonishing than the secretion of flinty earth by plants, which, though never suspected till within a few years, appears to me well ascertained. A substance is found in the hollow stem of the Bamboo, (*Arundo Bambos* of Linnæus, *Nastos* of Theophrastus,) called Tabaxir or Tabasheer, which is supposed in the East Indies (probably because it is rare and difficult of acquisition, like the imaginary stone in the head of a toad) to be endowed with extraordinary virtues. Some of it, brought to England, underwent a chemical examination, and proved, as nearly as possible, pure flint. See Dr. Russell's and Mr. Macie's papers on the subject in the *Phil. Trans. for* 1790 *and* 1791. It is even found occasionally in the Bamboo cultivated in our hot-houses. But we need not search exotic plants for flinty earth. I have already, in speaking of the Cuticle, chapter 3d, alluded to the discoveries of the late Professor of Chemistry at the Royal Institution, on this subject. That able chemist has detected pure flint in the cuticle of various plants of the family of Grasses, in the Cane (a kind of Palm) and in the Rough Horsetail, *Equisetum hyemale, Engl. Bot. t.* 915. In the latter it is very copious, and so disposed as to make a natural file, which renders this plant useful in various manufactures, for even brass cannot resist its action. Common Wheat straw, when burnt, is found to contain a portion of flinty earth in the form of a most exquisite powder, and this accounts for the utility of burnt straw in giving the last polish to marble. How great is the contrast between this production, if it be a secretion, of the tender vegetable frame, and those exhalations which constitute the perfume of flowers! One is among the most permanent substances in Nature, an ingredient in the primæval mountains of the globe; the other the invisible untangible breath of a moment!

The odour of plants is unquestionably of a resinous nature, a volatile essential oil and several phænomena attending it well deserve our attentive consideration. Its general nature is evinced by its ready union with spirits or oil, not with water; yet the moisture of the atmosphere seems, in many instances, powerfully to favour its diffusion. This I apprehend to arise more from the favourable action of such moisture upon the health and vigour of the plant itself, thus occasionally promoting its odorous secretions, than from the fitness of the atmosphere, so circumstanced, to convey them. Both causes however may operate. A number of flowers which have no scent in the course of the day, smell powerfully in an evening, whether the air be moist or dry, or whether they happen to be exposed to it or not. This is the property of some which Linnæus has elegantly called *flores tristes*, melancholy flowers, belonging to various tribes as discordant as possible, agreeing only in their nocturnal fragrance, which is peculiar, very similar and exquisitely delicious in all of them, and in the pale yellowish, greenish, or brownish tint of their flowers. Among these are *Mesembryanthemum noctiflorum*, *Dill. Elth. t.* 206, *Pelargonium triste*, *Cornut. Canad.* 110, and several species akin to it, *Hesperis tristis*, *Curt. Mag. t.* 730, *Cheiranthus tristis*, *t.* 729, *Daphne pontica*, *Andrews's Repos. t.* 73, *Crassula odoratissima*, *t.* 26, and many others*. A few more, greatly resembling these in the green hue of their blossoms, exhale, in the evening chiefly, a most powerful lemon-like scent, as *Epidendrum ensifolium*, *Sm. Spicil. t.* 24, and *Chloranthus inconspicuus*, *Phil. Trans. for* 1787, *t.* 14, great favourites of the Chinese, who seem peculiarly fond of this scent. There are other instances of odorous and aromatic secretions, similar among themselves, produced by very different plants, as Camphor. The sweet smell of new hay is found not only in *Anthoxanthum odoratum*, *Engl. Bot. t.* 647, and some other grasses, but in Woodruff or *Asperula odorata*, *t.* 755, Melilot or *Trifolium officinale*, *t.* 1340, and all the varieties, by some deemed species, of *Orchis militaris*, *t.* 16 and *t.* 1873, plants widely different from each other in botanical characters, as well as in colour and every particular except smell. Their odour has one peculiarity, that it is not at all perceptible while the plants are growing, nor till they begin to dry. It proceeds from their whole herbage, and should seem to escape from the orifices of its containing cells, only when the surrounding vessels, by growing less turgid, withdraw their pressure from such orifices. When this scent of new hay is vehement, it becomes the flavour of bitter almonds. The taste of syrup of capillaire, given by an infusion of Orange flowers, is found in the herbage of *Gaultheria procumbens*, *Andr. Repos. t.* 116, and *Spiræa Ulmaria*, *Engl. Bot. t.* 960, two very different plants.

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* These flowers afford the poet a new image, which is introduced into the following imitation of Martial, and offered here solely for its novelty :

Go mingle Arabia's gums
With the spices all India yields.
Go crop each young flower as it blooms.
Go ransack the gardens and fields.

Let Pæstum's all-flowery groves
Their roses profusely bestow.
Go catch the light zephyr that roves
Where the wild thyme and marjoram grow.

Let every pale night-scented flower,
Sad emblem of passion forlorn,
Resign its appropriate hour,
To enhance the rich breath of the morn.

All that art or that nature can find,
Not half so delightful would prove,
Nor their sweets all together combined,
Half so sweet as the breath of my love.

Some of the above examples show an evident analogy between the smell and colours of flowers, nor are they all that might be pointed out. A variety of the *Chrysanthemum indicum* *, *Curt. Mag. t.* 327, with orange-coloured flowers, was procured from China by the late Lady Amelia Hume. These faintly agree in scent, as they do in colour, with the Wall-flower, *Cheiranthus Cheiri*; whereas the common purple variety of the same *Chrysanthemum* has a totally different and much stronger odour.

There is, of course, still more analogy between the smell of plants in general and their impression on the palate, insomuch that we are frequently unable to discriminate between the two. The taste is commonly more permanent than the smell, but now and then less so. The root of the *Arum maculatum*, *Engl. Bot. t.* 1298, for instance, has, when fresh, a most acrid taste and irritating quality, totally lost by drying, when the root becomes simply farinaceous, tasteless and inert; so that well might learned physicians contrive the "Compound Powder of Arum," to excuse the continuance of its use in medicine, unless they had always prescribed the recent plant.—Many curious remarks are to be found in Grew relative to the tastes of plants, and their different modes of affecting our organs. *Anatomy of Plants, p.* 279—292.

To all the foregoing secretions of vegetables may be added those on which their various colours depend. We can but imperfectly account for the green so universal in their herbage, but we may gratefully acknowledge the beneficence of the Creator in clothing the earth with a colour the most pleasing and the least fatiguing to our eyes. We may be dazzled with the brilliancy of a flower-garden, but we repose at leisure on the verdure of a grove or meadow. Of all greens, the most delicate and beautiful perhaps is displayed by several umbelliferous plants under our hedges in the spring.

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* *Anthemis artemisiæfolia, Willd. Sp. Pl. v.* 3. 2184.

Some of Nature's richest tints and most elegant combinations of colour are reserved for the petals of flowers, the most transient of created beings; and even during the short existence of the parts they decorate, the colours themselves are often undergoing remarkable variations. In the pretty little weed called Scorpion-grass, *Myosotis scorpioides, Engl. Bot. t.*480, and several of its natural order, the flower-buds are of the most delicate rose-colour, which turns to a bright blue as they open. Many yellow flowers under the influence of light become white. Numbers of red, purple or blue ones are liable, from some unknown cause in the plant to which they belong, to vary to white. Such varieties are sometimes propagated by seed, and are almost invariably permanent if the plants be propagated by roots, cuttings, or grafting. Plants of an acid or astringent nature often become very red in their foliage by the action of light, as in *Rumex, Polygonum, Epilobium,* and *Berberis;* and it is remarkable that American plants in general, as well as such European ones as are particularly related to them, are distinguished for assuming various rich tints in their foliage of red, yellow, white, or even blue, at the decline of the year, witness the Guelder-rose, the Cornel, the Vine, the Sumach, the *Azalea pontica, Curt. Mag. t.* 433, and others. Fruits for the most part incline to a red colour, apparently from the acid they contain. I have been assured by a first-rate chemist that the colouring principle of the Raspberry is a fine blue, turned red by the acid in the fruit. The juices of some Fungi, as *Boletus bovinus* and *Agaricus deliciosus, Sowerb. Fungi, t.* 202, change almost instantaneously on exposure to the air, from yellow to dark blue or green.

These are a few hints only on a subject which opens a wide field of inquiry, and which, in professedly chemical works, is carried to a greater length than I have thought necessary in a physiological one. See *Thomson's Chemistry, v.* 4. and *Willdenow's Principles of Botany,* 229. We must ever keep in mind, as we explore it, that our anatomical instruments are not more inadequate to dissect the organs of a scarcely distinguishable insect, than our experiments are to investigate the fine chemistry of Nature, over which the living principle presides.

Before we take leave of the secreted fluids of vegetables, a few more remarks upon their direct utility to the plants themselves may not be superfluous. Malpighi first suggested that these secretions might nourish the plant, and our latest inquiries confirm the suggestion. Du Hamel compares them to the blood of animals, and so does Darwin. But the analogy seems more plain between the sap, as being nearly uniform in all plants, and the animal blood, as in that particular they accord, while the secreted fluids are so very various. Mr. Knight's theory confirms this analogy, at the same time that it establishes the opinion of Malpighi. The sap returning from the leaf, where it has been acted upon by the air and light, forming new wood, is clearly the cause of the increase of the vegetable body. But it is not so clear how the resinous, gummy or other secretions, laid aside, as it were, in vessels, out of the great line of circulation, can directly minister to the growth of the tree. I conceive they may be in this respect analogous to animal fat, a reservoir of nourishment whenever its ordinary supplies are interrupted, as in the winter, or in seasons of great drought, or of unusual cold. In such circumstances the mucilaginous or saccharine secretions especially, perhaps the most general of all, may be absorbed into the vegetable constitution; just as fat is into the animal one, during the existence of any disease that interrupts the ordinary supplies of food, or interferes with its due appropriation. It is well known that such animals as sleep through the winter, grow fat in the autumn and awake very lean in the spring. Perhaps the more recent layers of wood in a Plum- or Cherry-tree, if they could be accurately examined, might be found to contain a greater proportion of mucilage at the end of autumn than in the early spring. If these substances do not nourish the plant, they seem to be of no use to it, whatever secondary purposes they may answer in the schemes of Providence. The direct end, with respect to the plant, of the finer secreted fluids of its fruit can very well be perceived, as tempting the appetite of animals, and occasioning, through their means, the dispersion of the seeds; and the perfume of flowers may attract insects, and so promote the fertilization of the seed, as will be explained hereafter.

After what has been said we need not waste much time in considering the hypothesis, advanced by some philosophers, that the sap-vessels are veins and the returning vessels arteries. This is so far correct, that, as the chyle prepared by the digestive organs, poured into the veins and mixed with the blood, is, through the medium of the heart, sent into the lungs to be acted upon by the air; so the nutrimental juices of plants, taken up from the earth, which has been called their stomach, are carried by the sap-vessels into the leaves, for similar purposes already mentioned. The improved sap, like the vivid arterial blood, then proceeds to nourish and invigorate the whole frame. I very much doubt, however, if those who suggested the above hypothesis, could have given so satisfactory an explanation of it.

That the secretions of plants are wonderfully constant, appears from the operation of grafting. This consists in uniting the branches of two or more separate trees, as Dr. Hope's Willows, see *p.* 47, and a whole row of Lime-trees in the garden of New College, Oxford, whose branches thus make a network. This is called grafting by approach. A more common practice, called budding, or inoculating, is to insert a bud of one tree, accompanied by a portion of its bark, into the bark of another, and the tree which is thus engrafted upon is called the stock. By this mode different kinds of fruits, as apples, pears, plums, &c., each of which is only a variety accidentally raised from seed, but no further perpetuated in the same manner, are multiplied, buds of the kind wanted to be propagated being engrafted on so many stocks of a wild nature. The mechanical part of this practice is detailed in Du Hamel, Miller, and most gardening books. It is of primary importance that the *liber*, or young bark, of the bud, and that of the stock, should be accurately united by their edges. The air and wet must of course be excluded.

It is requisite for the success of this operation that the plants should be nearly akin. Thus the *Chionanthus virginica*, Fringe-tree, succeeds well on the Common Ash, *Fraxinus excelsior*, by which means it is propagated in our gardens. Varieties of the same species succeed best of all; but Apples and Pears, two different species of the same genus, may be grafted on one stock. The story of a Black Rose being produced by grafting a common rose, it is not worth inquiring which, on a black currant stock, is, as far as I can learn, without any foundation, and is indeed at the first sight absurd. I have known the experiment tried to no purpose. The rose vulgarly reported to be so produced is merely a dark Double Velvet Rose, a variety, as we presume, of *Rosa centifolia*. Another report of the same kind has been raised concerning the Maltese Oranges, whose red juice has been attributed to their being budded on a Pomegranate stock; of which I have never been able to obtain the smallest confirmation.

Heat can scarcely be denominated a secretion, and yet is undoubtedly a production, of the vegetable as well as animal body, though in a much lower degree in the former than the latter. The heat of plants is evinced by the more speedy melting of snow when in contact with their leaves or stems, compared with what is lodged upon dead substances, provided the preceding frost has been sufficiently permanent to cool those substances thoroughly. Mr. Hunter appears to have detected this heat by a thermometer applied in frosty weather to the internal parts of vegetables newly opened. It is evident that a certain appropriate portion of heat is a necessary stimulus to the constitution of every plant, without which its living principle is destroyed. Most tropical plants are as effectually killed by a freezing degree of cold, as by a boiling heat, and have nearly the same appearance; which is exemplified every autumn in the Garden Nasturtium, *Tropæolum* *majus*. The vegetables of cold climates, on the contrary, support a much greater degree of cold without injury, at least while in a torpid state; for when their buds begin to expand they become vastly more sensible, as is but too frequently experienced in the fickle spring of our climate. Nor is this owing, as vulgarly supposed, merely to the greater power of the cold to penetrate through their opening buds. It must penetrate equally through them in the course of long and severe winter frosts, which are never known to injure them. The extremely pernicious effects therefore of cold on opening buds can only be attributed to the increased susceptibility of the vital principle, after it has been revived by the warmth of spring.

The vegetation of most plants may be accelerated by artificial heat, which is called *forcing* them, and others may, by the same means, be kept in tolerable health, under a colder sky than is natural to them. But many alpine plants, naturally buried for months under a deep snow, are not only extremely impatient of sharp frosts, but will not bear the least portion of artificial heat. The pretty *Primula marginata*, *Curt. Mag. t.* 191, if brought into a room with a fire when beginning to blossom, never opens another bud; while the American Cowslip, *Dodecatheon Meadia*, *t.* 12, one of the most hardy of plants with respect to cold, bears forcing admirably well.

Mr. Knight very satisfactorily shows, *Phil. Trans. for* 1801, 343, that plants acquire habits with regard to heat which prove their vitality, and that a forced Peach-tree will in the following season expand its buds prematurely in the open air, so as to expose them to inevitable destruction. See *p.* 50. A thousand parallel instances may be observed, by the sagacious gardener, of plants retaining the habits of their native climates, which very often proves one of the greatest impediments to their successful cultivation.

The most remarkable account that has fallen in my way concerning the production of heat in plants, is that given by Lamarck in his *Flore Françoise*, *v.* 3. 538, of the Common *Arum maculatum*, *Engl. Bot. t.* 1298, (the white-veined variety,) the flower of which, at a certain period of its growth, he asserts to be, for a few hours, "so hot as to seem burning." The learned M. Senebier of Geneva, examining into this fact, discovered that the heat began when the sheath was about to open, and the cylindrical body within just peeping forth; and that it was perceptible from about three or four o'clock in the afternoon till eleven or twelve at night. Its greatest degree was seven of Reaumur's scale above the heat of the air, which at the time of his observation was about fourteen or fifteen of that thermometer. Such is the account with which I have been favoured by Dr. Bostock of Liverpool, from a letter of M. Senebier*, dated

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* It is now published in his *Physiologie Végétale, v.* 3. 314, where nevertheless this ingenious philosopher has declared his opinion to be rather against the existence of a spontaneous heat

Nov. 28, 1796, to M. De la Rive. I have not hitherto been successful in observing the phænomenon in question, which however is well worthy of attention, and may probably not be confined to this species of *Arum*.

in vegetables, and he explains even the above striking phænomenon upon chemical principles, which seem to be very inadequate.

CHAPTER XI.

THE PROCESS OF VEGETATION. USE OF THE COTYLEDONS.

WHEN a seed is committed to the ground it swells by the moisture which its vessels soon absorb, and which, in conjunction with some degree of heat, stimulates its vital principle. Atmospherical air is also necessary to incipient vegetation, for seeds in general will not grow under water, except those of aquatic plants, nor under an exhausted receiver; and modern chemists have determined oxygen gas, which is always an ingredient in our atmosphere, to be absorbed by seeds in vegetation. An experiment is recorded in the Philosophical Transactions, No. 23, of sowing Lettuce-seed in two separate pots, one of which was placed in the common air, the other in the vacuum of an air-pump. In the former the young plants rose to the height of two inches, or more, in a week's time; in the other none appeared, till after the pot had been removed for a similar period into the air again. Seeds buried in the ground to a greater depth than is natural to them do not vegetate, but they often retain their power of vegetation for an unlimited period. Earth taken from a considerable depth will, when exposed to the air, be soon covered with young plants, especially of Thistles, or of the Cress or Mustard kind, though no seeds have been allowed to have access to it. If the ground in old established botanic gardens be dug much deeper than ordinary, it frequently happens that species which have been long lost are recovered, from their seeds being latent in the soil, as I have been assured by Mr. Fairbairn of Chelsea garden, and others.

The integuments of the seed, having fulfilled their destined office of protection, burst and decay. The young root is the first part of the infant plant that comes forth, and by an unerring law of Nature it is sent downwards, to seek out nourishment as well as to fix the plant to the ground. In sea-weeds, *Fuci*, *Ulvæ* and *Confervæ*, it seems chiefly to answer the latter purpose. In the Dodder, *Cuscuta*, a parasitical plant, the original root lasts only till the stems have established themselves on some vegetable, on whose juices they feed by means of other roots or fibres, and then withers away.

The descent of the root, and the ascent of the leaf-bud in a contrary direction, are ingeniously explained by Dr. Darwin, *Phytologia*, *sect.* 9. 3, on the principle of the former being stimulated by moisture, and the latter by air, whence each elongates itself where it is most excited. This is perhaps more satisfactory than any mechanical hypothesis. In whatever position seeds happen to lie in the earth, the root makes more or less of a curve in order to shoot downwards. Mr. Hunter sowed a number of seeds in a basket of earth placed on an axis, by which their position was a little altered every day. After the basket had thus made two or three circumvolutions, the young roots were found to have formed as many turns in attempting to attain their natural perpendicular direction. Mr. Knight has ascertained, *Phil. Trans. for* 1806, that a strong centrifugal force applied to vegetating seeds will considerably divert the root from this direction outwards, while the stem seems to have a centripetal inclination.

The young root, if it grew in a soil which afforded no inequality of resistance, would probably in every case be perfectly straight, like the radical fibres of bulbous roots in water; but as scarcely any soil is so perfectly homogeneous, the root acquires an uneven or zigzag figure. It is elongated chiefly at its extremity*, and has always, at that part especially, more or less of a conical or tapering figure.

When the young root has made some progress, the two lobes, commonly of a hemispherical figure, which compose the chief bulk of the seed, swell and expand, and are raised out of the ground by the ascending stem. These are called the *Cotyledons*, *f.* 4. Between them is seated the *Embryo* or germ of the plant, called by Linnæus *Corculum* or little heart, in allusion to the heart of the walnut. Mr. Knight denominates it the germen, but that term is appropriated to a very different part, the rudiment of the fruit. The expanding *Embryo*, resembling a little feather, has been for that reason named by Linnæus *Plumula*; it soon becomes a tuft of young leaves, with which the young stem, if there be any, ascends. Till the leaves unfold, and sometimes after, the cotyledons, assuming their green colour, perform their functions; then the latter generally wither. This may be seen in the Radish, Lupine, Garden Bean, and various umbelliferous plants, in all which the expanded cotyledons are remarkably different from the true leaves. Such is the general course of vegetation in plants furnished with two cotyledons, or *dicotyledones*; but I have already mentioned a very distinct tribe called *monocotyledones*; see *p.* 45. These are the Grass and Corn tribe, Palms, the beautiful *Orchis* family, and many others. In these the body of the seed does not ascend out of the ground, and they are rather to be considered as having no cotyledon at all. See Mr. Salisbury's paper in the Transactions of the Linnean Society, *v.* 7, on the germination of the Orchis tribe. We reserve more particular remarks on this subject till we examine the structure of seeds.

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* As may be seen by marking the fibres of Hyacinth roots in water, or the roots of Peas made to vegetate in wet cotton wool.

Some plants are reckoned by Linnæus to have many cotyledons, as the Fir and Cypress. But the germination of these differs in no respect from that of the generality of *dicotyledones*. Mr. Lambert, in his splendid history of the genus *Pinus*, has illustrated this peculiarity of structure in the Swiss *P. Cembra*; see our *tab.* 1, *fig.* 2. In the *Dombeya*, or Norfolk

Island Pine, the cotyledons are very distinctly four: see *fig.* 3.

The preservation of the vital principle in seeds is one of those wonders of Nature which pass unregarded, from being every day under our notice. Some lose their vegetative power by being kept out of the ground ever so little a while after they are ripe, and in order to succeed must sow themselves, in their own way, and at their own time. Others may be sent round the world through every vicissitude of climate, or buried for ages deep in the ground, till favourable circumstances cause them to vegetate. Great degrees of heat, short of boiling, do not impair the vegetative power of seeds, nor do we know any degree of cold that has such an effect. Those who convey seeds from distant countries, should be instructed to keep them dry; for, if they receive any damp sufficient to cause an attempt at vegetation, they necessarily die, because the process cannot, as they are situated, go on. If, therefore, they are not exposed to so great an artificial heat as might change the nature of their oily juices, they can scarcely, according to the experience of Mr. Salisbury, be kept in too warm a place. By the preservation of many seeds so long under ground, it seems that long-continued moisture is not in itself fatal to their living powers; neither does it cause their premature germination, unless accompanied by some action of the air.

It is usual with gardeners to keep Melon and

Cucumber seeds for a few years, in order that the future plants may grow less luxuriantly, and be more abundant in blossoms and fruit. Dr. Darwin accounts for this from the damage which the cotyledons may receive from keeping, by which their power of nourishing the infant plant, at its first germination, is lessened, and it becomes stunted and dwarfish through its whole duration.

Dr. Thomson of Edinburgh, in his System of Chemistry, *vol.* 4. 374, has published a very satisfactory explanation of one part of the functions of the cotyledons. Several philosophers have discovered that very soon after the seed begins to imbibe moisture, it gives out a quantity of carbonic acid gas, even though no oxygen gas be present. In this case the process stops here, and no germination takes place. But if oxygen gas be present, it is gradually absorbed in the same proportion. At the same time the farina of the cotyledons becomes sweet, being converted into sugar. "Hence it is evident," says this intelligent writer, "that the farina is changed into sugar, by diminishing its carbon, and of course by augmenting the proportion of its hydrogen and oxygen[*]. This is precisely the process of malting, during which it is well known that there is a considerable heat evolved. We may conclude from this, that during the germination of seeds in the earth there is also an evolution of a considerable portion of heat. This indeed might have been expected, as it usually happens when oxygen gas is absorbed. So far seems to be the work of chemistry alone; at least we have no right to conclude that any other agent interferes; since *hay*, when it happens to imbibe moisture, exhibits nearly the same processes."

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[*] This is also the opinion of M. de Saussure, *Recherches Chimiques sur la Végétation, p.* 16.

I conceive the evolution of this heat may powerfully further the progress of vegetation by stimulating the vital principle of the embryo, till its leaves unfold and assume their functions. It is necessary to observe, that the above process equally takes place, whether the farinaceous particles be lodged in the bulk of the cotyledons themselves, or compose a separate body called by authors the *albumen*, as in grasses and corn.

CHAPTER XII.

OF THE ROOT, AND ITS DIFFERENT KINDS.

We begin the description of the completely formed vegetable by its Root, as being the basis of all the rest, as well as the first part produced from the seed. Its use in general is two-fold; to fix the plant to a commodious situation, and to derive nourishment for its support. This part is therefore commonly plunged deeply into the ground, having, as we have already shown, a natural tendency to grow downwards. In some cases however, when plants grow on the stems or branches of others, as the Dodder or *Cuscuta*, several Ferns, and a portion of the Orchis tribe, the root is closely attached to the bark, from which it draws nourishment, by the under side only, the upper being bare.

The Root consists of two parts, *Caudex* the body of the root, and *Radicula* the fibre. The latter only is essential, being the part which imbibes nourishment.

Roots are either of annual, biennial or perennial duration. The first belong to plants which live only one year, or rather one summer, as Barley; the second to such as are produced one season, and, living through the ensuing winter, produce flowers and fruit the following summer, as Wheat; and the third to those which live and blossom through many succeeding seasons to an indefinite period, as trees, and many herbaceous plants. The term biennial is applied to any plant that is produced one year and flowers another, provided it flowers but once, whether that event takes place the second year, as usual, or whether, from unfavourable circumstances, it may happen to be deferred to any future time. This is often the case with the *Lavatera arborea*, Tree Mallow, *Engl. Bot. t.* 1841, and some other plants, especially when growing out of their natural soil or station. Linnæus justly observes that, however hardy with respect to cold such plants may prove before they blossom, they perish at the first approach of the succeeding winter, nor can any artificial heat preserve them. This is, no doubt, to be attributed to the exhaustion of their vital energy by flowering. Several plants of hot climates, naturally perennial and even shrubby, become annual in our gardens, as the *Tropæolum*, Garden Nasturtium.

In the Turnip, and sometimes the Carrot, Parsnep, &c., the *Caudex* or body of the root is above-ground and bare, becoming as it were a stem. Linnæus indeed calls the stems of trees "roots above ground;" but this seems paradoxical and scarcely correct. Perhaps it would be more accurate to say the *caudex* is a subterraneous stem; but we rather presume it has functions distinct from the stem, analogous, as has been hinted *p.* 43, to digestion, at least in those plants whose stems are annual though their roots are perennial.

The fibres of the root, particularly those extremities of them which imbibe nourishment from the earth, are in every case strictly annual. During the winter, or torpid season of the year, the powers of roots lie dormant, which season therefore is proper for their transplantation. After they have begun to throw out new fibres, it is more or less dangerous, or even fatal, to remove them. Very young annual plants, as they form new fibres with great facility, survive transplantation tolerably well, provided they receive abundant supplies of water by the leaves till the root has recovered itself.

Botanists distinguish several different kinds of roots, which are necessary to be known, not only for botanical purposes, but as being of great importance in agriculture and gardening. The generality of roots may be arranged under the following heads.

1. *Radix fibrosa*, *fig.* 5. A Fibrous Root. The most simple in its nature of all, consisting only of fibres, either branched or undivided, which convey nourishment directly to the basis of the stem or leaves. Many grasses, as *Poa annua*, *Engl. Bot. t.* 1141, and the greater part of annual herbs, have this kind of root. The radical fibres of grasses that grow in loose sand are remarkably downy, possibly for the purpose of fixing them more securely to so slippery a support, or to multiply the surface or points of absorption in so meagre a source of nutriment. The fibres of some parasitical plants already alluded to,

chiefly of the beautiful genus *Epidendrum*, are peculiarly thick and fleshy, not only for the purpose of imbibing the more nourishment, but also to bind them so strongly to the branches of trees, as to defy the force of winds upon their large and rigid leaves.

2. *Radix repens*, *f.* 6. A Creeping Root, as in Mint, *Mentha*. A kind of subterraneous stem, creeping and branching off horizontally, and throwing out fibres as it goes. This kind of root is extremely tenaceous of life, for any portion of it will grow. Hence weeds furnished with it are among the most troublesome, as the different sorts of Couch-grass, *Triticum repens*, *Engl. Bot. t.* 909, *Holcus mollis*, *t.* 1170, &c.; while, on the other hand, many sea-side grasses, having such a root, prove of the most important service in binding down loose blowing sand, and so resisting the encroachments of the ocean. These are principally *Carex arenaria*, *Engl. Bot. t.* 928, *Arundo arenaria*, *t.* 520, and *Elymus arenarius*, *t.* 1672.

3. *Radix fusiformis*, *f.* 7. A Spindle-shaped or Tapering Root. Of this the Carrot, Parsnep and Radish are familiar examples. Such a root is formed, on the principle of a wedge, for penetrating perpendicularly into the ground. It is common in biennial plants, but not peculiar to them. The *caudex*, which is the spindle-shaped part, abounds with the

proper secreted juices of the plant, and throws out numerous fibres or radicles, which are in fact the real roots, as they alone imbibe nourishment.

4. *Radix præmorsa*, *f.* 8. An Abrupt Root, is naturally inclined to the last-mentioned form, but from some decay or interruption in its descending point, it becomes abrupt, or as it were bitten off. *Scabiosa succisa*, *Devil's-bit Scabious*, *Engl. Bot. t.* 878, *Hedypnois hirta*, *t.*555, and some other Hawkweeds, have this kind of root, the old opinion concerning which cannot be better described than in Gerarde's Herbal, under the plant first named, *p.* 726.

"The great part of the root seemeth to be bitten away: old fantasticke charmers report, that the divel did bite it for envie, because it is an herbe that hath so many good vertues, and is so beneficial to mankinde."——The malice of the devil has unhappily been so successful that no virtues can now be found in the remainder of the root or herb.

5. *Radix tuberosa*, *f.* 9. A Tuberous or Knobbed Root, is of many different kinds. The most genuine consists of fleshy knobs, various in form, connected by common stalks or fibres, as in the Potatoe, *Solanum tuberosum*, and Jerusalem Artichoke*,

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* A corruption, as I presume, of the Italian name *Girasole Articiocco*, sun-flower Artichoke, as the plant was first brought from Peru to Italy, and thence propagated throughout Europe.

Helianthus tuberosus Jacq. Hort. Vind. t. 161. These knobs are reservoirs of nourishment, moisture, and vital energy. Several of the Vetch or Pea kind are furnished with them on a smaller scale; see *Vicia lathyroides*, *Engl. Bot. t.* 30, and several species of *Trifolium*, either annuals, as *glomeratum*, *t.* 1063, or perennials, as *fragiferum*, *t.* 1050. —The knobs in these instances are only of annual duration; in the *Pæonia*, Pæony, *t.* 1513, and *Spiræa Filipendula*, Dropwort, *t.* 284, they are perennial.—In the *Orchideæ* of Europe they are mostly biennial. The root in many of the latter consists either of a pair of globular or oval bodies, *f.* 10, as in *Satyrium hircinum*, *Engl. Bot. t.* 34, *Ophrys aranifera*, *t.* 65, and *apifera*, *t.* 383; or are palmate, that is, shaped somewhat like the human hand, *f.* 11, as in *Orchis maculata*, *t.* 632. Of these globular or palmate knobs or bulbs one produces the herb and flowers of the present year, withering away towards autumn, and the other is reserved for the following season, while in the mean time a third is produced to succeed the latter. The knobs of *Ophrys spiralis*, *t.* 541, are formed three or four years before they flower, and their flowering appears to be occasionally deferred to a more distant period. The roots of *Satyrium albidum*, *t.* 505, consists of three pair of tapering knobs or bulbs, *f.* 12, which flower in succession. On the contrary, *Ophrys monorchis*, *t.* 71, forms its new bulb so late that it is not perfected till the autumn immediately preceding its flowering, and the plant seems to have but one bulb. *Ophrys Nidus avis*, *t.* 48, has clusters of cylindrical knobs, which are formed, and also wither away, in parcels, each parcel being equivalent to one of the above-mentioned bulbs.

Such of the *Orchis* tribe as have biennial bulbs are supposed to be very difficult of cultivation; but according to the experience of my excellent friend the late Mr. Crowe, in whose garden I have seen them many successive years, they are best removed when in full flower, the earth being cleared completely away from the roots, which are then to be replanted in their natural soil previously dried and sifted. Afterwards they must be well watered. The bulb for the following year has not, at the flowering period, begun to throw out its fibres; for after that happens, it will not bear removal. *Satyrium albidum* having, as mentioned above, so many pair of roots, the growth of some of which is always going on, has hitherto not been found to survive transplantation at all.

Iris tuberosa, *Sm. Fl. Græc. Sibth. t.* 41, has a root very analogous to these just described, but *I. florentina* and *I. germanica*, *t.* 39 and 40 of the same work, have more properly creeping roots, though so thick and fleshy in their substance, and so slow in their progress, that they are generally denominated tuberous.

6. *Radix bulbosa.* A Bulbous Root, properly so called, is either solid, *f.* 13, as in *Crocus*, *Ixia*, *Gladiolus*, &c.; tunicate, *f.* 14, *tunicata*, composed of concentric layers enveloping one another as in *Allium*, the Onion tribe; or scaly, *f.* 15, consisting of fleshy scales connected only at their base, as in *Lilium*, the White or Orange Lily. The two latter kinds have the closest analogy with leaf-buds. They are reservoirs of the vital powers of the plant during the season when those powers are torpid or latent, and in order to perform the functions of roots, they first produce fibres, which are the actual roots. The strict affinity between bulbs and buds appears from the scaly buds formed on the stem of the Orange Lily, *Lilium bulbiferum*, which fall to the ground, and, throwing out fibres from their base, become bulbous roots*. The same thing happens in *Dentaria bulbifera*, *Engl. Bot. t.* 309, and *Saxifraga cernua*, *t.* 664.

These two last-mentioned plants however have scaly roots, like the Toothwort, *Lathræa Squamaria*, *t.* 50, which seem bulbs lengthened out. Whether they would, in the torpid season of the year, bear removal, like bulbs, we have no information. If disturbed at other times they are immediately killed.

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* I have had scaly buds form even on the flower-stalk of *Lachenalia tricolor*, *Curt. Mag. t.* 82, whilst lying for many weeks between papers to dry, which, on being put into the ground, have become perfect plants, though of slow growth.

Many plants with solid bulbs are provided by Nature to inhabit sandy countries, over the face of which, in the dry season succeeding their flowering, they are scattered by the winds to a great distance, as happens to our own *Poa bulbosa*, *Engl. Bot. t.* 1071, as well as to numerous beautiful productions of the Cape of Good Hope.

7. *Radix articulata*, or *granulata*, *f.* 16. A Jointed or Granulated Root agrees very much with those described in the last section. The *Oxalis Acetosella*, Wood Sorrel, *Engl. Bot. t.* 762, and *Saxifraga granulata*, White Saxifrage, *t.* 500, are instances of it. The former has most affinity with scaly bulbs, the latter with solid ones.

It is evident that fleshy roots, whether of a tuberous or bulbous nature, must, at all times, powerfully resist drought. We have already mentioned, *p.* 32, the acquisition of a bulb in *Phleum pratense*, *Engl. Bot. t.* 1076, whenever that grass is situated in a fluctuating soil, by which its vital powers are supported while the fibrous roots are deprived of their usual supplies. In this state it becomes the *Phleum nodosum* of authors; but on being removed to a thoroughly wet soil, it resumes the entirely fibrous root, and luxuriant growth, of *Ph. pratense.* I have also found *Alopecurus geniculatus*, *t.* 1250, (an aquatic grass, whose root is naturally fibrous and creeping,) growing with an ovate juicy bulb on the top of a dry wall. This variety has been taken for the true *A. bulbosus*, *t.* 1249, which has always bulbs, even in its native marshes. We see the wisdom of this provision of Nature in the grasses above mentioned, nor may the cause be totally inexplicable. When a tree happens to grow from seed on a wall, it has been observed, on arriving at a certain size, to stop for a while, and send down a root to the ground. As soon as this root was established in the soil, the tree continued increasing to a large magnitude*. Here the vital powers of the tree not being adequate, from scanty nourishment, to the usual annual degree of increase in the branches, were accumulated in the root, which therefore was excited to an extraordinary exertion, in its own natural direction, downward. There is no occasion then to suppose, as some have done, that the tree had any information of the store of food at the foundation of the wall, and voluntarily sent down its root to obtain it; nor is it wonderful that the Author of life should provide for it as effectually as it could for itself, had it really been a reflecting being. So in the case of the grasses in question, I presume the herb being in the first instance starved, by a failure of the nutrimental fluids hitherto conveyed by the water of the soil, its growth would be checked, and when checked, the same growth could not, as we know by observation on vegetation in general, be instantaneously renewed. A sudden fresh supply of food would therefore cause an accumulation of vital energy in the root, which would consequently assume a degree of vigour and a luxuriant mode of growth not natural to it, and become bulbous. Thus it acquires a resource against such checks in future, and the herb is preserved alive, though in a very far less luxuriant state than when regularly and uniformly supplied with its requisite nourishment. These are not solitary instances. It is well worthy the attention of an intelligent cultivator to seek them out, and turn them to his advantage.

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* A particular fact of this kind concerning an ash was communicated to me by the late Rev. Dr. Walker of Edinburgh. See also *Trans. of Linn. Soc. v.* 2. 268.

CHAPTER XIII.

DIFFERENT KINDS OF STEMS AND STALKS OF PLANTS.

LINNÆUS enumerates seven kinds of Trunks, Stems, or Stalks of Vegetables. These are necessary to be known, for botanical distinctions, though some are more important than others, both in that respect and in a physiological point of view.

1. CAULIS. A Stem properly so called, which bears, or elevates from the root, the leaves as well as flowers. The trunks and branches of all trees and shrubs come under this denomination, as well as of a great proportion of herbaceous plants, especially annuals.

The Stem is either simple, as in the White Lily, or branched, as in most instances. When it is regularly and repeatedly divided, and a flower springs from each division, it is called *caulis dichotomus*, *f.* 17, a forked stem, as in *Chlora perfoliata*, *Engl. Bot. t.* 60, as well as the common Mouse-ear Chickweeds, *Cerastium vulgatum*, *t.* 789, and *viscosum*, *t.* 790.

Though generally leafy, a Stem may be partially naked, or even entirely so in plants destitute of leaves altogether, as the Creeping Cereus, *Cactus flagelliformis*, *Curt. Mag. t.* 17, various exotic species of *Euphorbia* or Spurge, and the whole genus of *Stapelia*. In *Orobanche*, it is scaly, *f.* 18, *squamosus*.

With respect to mode of growth, the Stem is

Erectus, upright, as in Yellow Loosestrife, *Lysimachia vulgaris*. *Engl. Bot. t.* 761.

Procumbens, procumbent, Wood Loosestrife, *L. nemorum*, *t.* 527.

Repens, creeping, Creeping Loosestrife, *L. Nummularia*, *t.* 528, and Creeping Crowfoot, *Ranunculus repens*, *t.* 516.

Adscendens, ascending obliquely without support, as *Panicum sanguinale*, *t.* 849.

Prostratus, prostrate, or *Depressus*, depressed, when it lies remarkably flat, spreading horizontally over the ground, as in *Coldenia procumbens*; also *Coronopus Ruellii*, Swine's-cress, *Engl. Bot. t.* 1660.

Reclinatus, reclining, curved towards the ground, as in *Ficus*, the Fig, *Rubus*, the Bramble, &c.

Radicans, *f.* 19, clinging to any other body for support, by means of fibres which do not imbibe nourishment, as Ivy, *Hedera Helix*, *Engl. Bot. t.* 1267, *Vitis quinquefolia*, *Sm. Insects of Georgia*, *t.* 30. *Bignonia radicans*, *Curt. Mag. t.* 485.—Linnæus, *Philosophia Botanica* 39, has expressed this by the term *repens*, but has corrected it in his own copy. Still he does not distinguish between these plants, and those whose stems throw out real roots, which last only are justly called *creeping*, whether they grow on the ground, like those above mentioned, or on other plants like *Cuscuta*, Dodder, *Engl. Bot. t.* 55 and 378. See *p.* 73.

Scandens, climbing; either with spiral tendrils for its support, as the Vine, *Vitis*, the various species of Passion-flower, *Passiflora cærulea, Curt. Mag. t.* 28, *alata, t.* 66, &c. and *Bryonia dioica*, Red-berried Bryony, *Engl. Bot. t.* 439; or by adhesive fibres, as in the preceding paragraph.

Volubilis, twining round other plants by its own spiral form, either from left to right, *f.* 20, supposing the observer in the centre, (or in other words, according to the apparent motion of the sun,) as the Black Bryony, *Tamus communis, Engl. Bot. t.* 91, the Honeysuckles, *Lonicera Caprifolium, t.* 799, and *Periclymenum, t.* 800, and the *Polygonum Convolvulus, t.* 941; or from right to left, *f.* 21, contrary to the sun, as the Great Bindweed, *Convolvulus sepium, t.* 313, the French Bean, *Phaseolus vulgaris, Ger. em.* 1212, *fig.* 1, &c.—Figures of plants being sometimes reversed by the engraver, in that case give a wrong representation of the circumstance in question, witness *Lonicera Periclymenum* in Curtis's *Flora Londinensis, fasc.* 1. *t.* 15, and many instances might be pointed out of its not being attended to at all.

Flagelliformis, long and pliant, like the Common Jasmine, *Jasminum officinale*, *Curt. Mag. t.* 31, or Blue Box-thorn, *Lycium barbarum*.

Sarmentosus, trailing. A creeping stem, barren of flowers, thrown out from the root for the purpose of increase, is called *sarmentum* or *flagellum*, a runner, *f.* 22, as in the Strawberry, *Fragaria vesca*, *Engl. Bot. t.* 1524. When leafy it is generally denominated *stolo*, a sucker or scyon, as in Bugle, *Ajuga reptans*, *t.* 489, and *Viola odorata*, the Sweet Violet, *t.* 619. When the *stolo* has taken root, it sometimes flowers the first year, see *Curt. Lond. fasc.* 1. *t.* 63, but generally not till the following season.

Rectus, straight, as in *Lilium*, the different species of garden Lily.

Strictus, expresses only a more absolute degree of straightness.

Laxus or *Diffusus*, loosely spreading, has a contrary meaning, as in *Bunias Cakile*, Sea Rocket, *Engl. Bot. t.* 231, and *Sedum acre*, Biting Stone-crop, *t.* 839.

Flexuosus, zigzag, forming angles alternately from right to left and from left to right, as in *Smilax aspera*, *Ger. em.* 859, and many of that genus, also *Statice reticulata*, Matted Sea Lavender, *Engl. Bot. t.* 328. In a less degree it is not unfrequent. See *Atriplex pedunculata*, *t.* 232.

Alternè ramosus, alternately branched, as *Polygonum minus*, *t.* 1043, *Dianthus deltoides*, *t.* 61, &c.

Distichus, two-ranked, when the branches spread in two horizontal directions, as in the Silver Fir, *Pinus picea*, *Duhamel*, *Arb*. *v*. 1. *t*. 1.

Brachiatus, brachiate, or four-ranked, when they spread in four directions, crossing each other alternately in pairs; a very common mode of growth in shrubs that have opposite leaves, as the Common Lilac, *Syringa vulgaris*.

Ramosissimus, much branched, is applied to a stem repeatedly subdivided into a great many branches without order, as that of an Apple- or Pear-tree, or Gooseberry-bush.

Prolifer, proliferous, shooting out new branches from the summits of the former ones*, as in the Scotch Fir, *Pinus sylvestris*, *Lambert's Pinus*, *t.* 1. and *Lycopodium annotinum*, *Engl. Bot.* *t.* 1727. This is obsolete, and seldom used.

Determinatè ramosus, *f.* 23, abruptly branched, when each branch, after terminating in flowers, produces a number of fresh shoots in a circular order from just below the origin of those flowers. This term occurs frequently in the later publications of Linnæus, particularly the second *Mantissa*, but I know not that he has any where explained its meaning. It is exemplified in *Azalea nudiflora*, *Curt. Mag. t.* 180, *Erica Tetralix*, *Engl. Bot. t.* 1014, many Cape Heaths, and other shrubs of the same Natural Order.

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* *Linn. Phil. Bot. sect.* 82. 28.

Articulatus, jointed, as in Samphire, *Salicornia annua*, *Engl. Bot. t.* 415, and more remarkably in the Indian Figs, *Cactus Tuna*, &c.

In shape the Stem is

Teres, *f.* 32, round, as in *Trollius europæus*, *Engl. Bot. t.* 28, and *Hydrangea hortensis*, *Sm. Ic. Pict. t.* 12.

Anceps, two-edged, as *Sisyrinchium striatum*, *Sm. Ic. Pict. t.* 9. *S. gramineum*, *Curt. Mag. t.* 464, and some of the genus *Lathyrus*.

Trigonus, or *Triangularis*, triangular or three-edged, as *Cactus triangularis*, *Plukenet*, *t.* 29, *f.* 3.

Triqueter, three-sided, is applied to a stem with 3 flat sides.

Tetragonus, or *Quadrangularis*, square, as *Lamium album*, White Dead-nettle, *Engl. Bot. t.* 768, and a multitude of other plants.

Pentagonus, or *Quinquangularis*, five-sided, as *Asparagus horridus*, *Cavanilles Ic. t.* 136, where however the character is not well expressed.

When the number of angles is either variable, or more than five, it is usual merely to describe the stem as *angulosus*, angular, except where the precise number makes a specific difference, as in the genus *Cactus*.

Alatus, *f.* 36, winged, when the angles are extended into flat leafy borders, as *Passiflora alata*, *Curt. Mag.* *t.* 66, *Lathyrus latifolius*, *Engl. Bot.* *t.* 1108, and many others of the Pea kind, besides several Thistles, as *Carduus acanthoides*, *t.* 973, *palustris*, *t.* 974, and *Centaurea solstitialis*, *t.* 243.

The surface of the Stem is

Glaber, smooth, opposed to all kinds of hairiness or pubescence, as in Petty Spurge, *Euphorbia Peplus*, *Engl. Bot. t.* 959, and numerous plants besides.

Lævis, smooth and even, opposed to all roughness and inequality whatever, as in the last example, and also *Euonymus europæus*, *t.* 362.

Nitidus, polished, smooth and shining, as *Chærophyllum sylvestre*, *t.* 752.

Viscidus, viscid, covered with a clammy juice, as *Lychnis Viscaria*, *t.* 788.

Verrucosus, warty, like *Euonymus verrucosus*, *Jacq. Fl. Austriaca*, *t.* 49, and *Malpighia volubilis*, *Curt. Mag. t.* 809.

Papillosus, papillose, covered with soft tubercles, as the Ice plant, *Mesembryanthemum crystallinum*. *Dill. Elth. t.* 180.

Scaber, rough to the touch from any little rigid inequalities, opposed to *lævis*, as *Caucalis An-*

thriscus, *Engl. Bot. t.* 987, *Centaurea nigra*, *t.* 278, and *Stellaria holostea*, *t.* 511.

Hispidus, bristly, as Borage, *Borago officinalis*, *t.* 36, and *Chara hispida*, *t.* 463.

Hirtus, or *Pilosus*, hairy, as *Salvia pratensis*, *t.* 153, and *Cerastium alpinum*, *t.* 472.

Tomentosus, downy, as *Geranium rotundifolium*, *t.* 157, very soft to the touch.

Villosus, shaggy, as *Cineraria integrifolia*, *t.* 152.

Lanatus, woolly, as *Verbascum pulverulentum*, *t.* 487, *V. Thapsus*, *t.* 549, and *Santolina maritima*, *t.* 141.

Incanus, hoary, as Wormwood, *Artemisia Absinthium*, *t.* 1230, and *Atriplex portulacoides*, *t.* 261, in the former case from close silky hairs, in the latter from a kind of scaly mealiness.

Glaucus, clothed with fine sea-green mealiness which easily rubs off, as *Chlora perfoliata*, *t.* 60, and *Pulmonaria maritima*, *t.* 368.

Striatus, striated, marked with fine parallel lines, as *Oenanthe fistulosa*, *t.* 363.

Sulcatus, furrowed, with deeper lines, as *Smyrnium Olusatrum*, *t.* 230.

Maculatus, spotted, as Hemlock, *Conium maculatum*, *t.* 1191.

The spines and prickles of the stem will be explained hereafter.

Internally the stem is either *solidus*, solid, as that of *Inula crithmoides*, *t.* 68, and numerous others; or *cavus*, hollow, as in *Cineraria palustris*, *t.* 151, as well as Hemlock, and many umbelliferous plants besides.

Plants destitute of a stem are called *acaules*, stemless, as *Cypripedium acaule*, *Curt. Mag. t.* 192, and *Carduus acaulis*, *Engl. Bot. t.* 161. Such plants, when they belong to a genus or family generally furnished with stems, as in these instances and *Carlina acaulis*, *Camer. Epit.* 428, are liable from occasional luxuriance to acquire some degree of stem, but seldom otherwise*. *Pinguicula*, *Engl. Bot. t.* 70 and 145, is a genus invariably stemless, while *Primula*, *t.* 4, 5, 6 and 513, is much less truly so. The term *acaulis* however must never be too rigidly understood, for logical precision is rarely applicable to natural productions.

Caulis fasciculatus, a clustered stem, is a disease or accident, in which several branches or stems are united longitudinally into a flat broad figure, crowded with leaves or flowers at the extremity. It occurs in the Ash, several species of *Daphne*, *Ranunculus*, *Antirrhinum*, &c. In *Pisum comosum* of Rivinus, called the Top-knot Pea, it is a permanent variety propagated by seed.

2. Culmus. A straw or Culm, is the peculiar Stem

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* *Neottia acaulis*, *Exot. Bot. t.* 105, proves to have a stem, when in perfection, and is now properly called *N. picta* by Dr. Sims in *Curt. Mag. t.* 1562.

of the Grasses, Rushes, and plants nearly allied to them. It bears both leaves and flowers, and its nature is more easily understood than defined. Many botanists have thought this term superfluous.

The Culm is occasionally

Enodis, without joints, as in our common Rushes, *Juncus conglomeratus*, *Engl. Bot. t.* 835, and *effusus*, *t.* 836;

Articulatus, jointed, as in *Agrostis alba*, *t.* 1189, *Aira canescens*, *t.* 1190, *Avena strigosa*, *t.* 1266, and most other grasses;

Geniculatus, bent like the knee, as *Alopecurus geniculatus*, *t.* 1250.

It is either solid or hollow, round or triangular, rough or smooth, sometimes hairy or downy, scarcely woolly. I know of no instance of such a scaly culm as Linnæus has figured in his *Philosophia Botanica*, *t.* 4, *f.* 111, nor can I conceive what he had in view.

3. Scapus, a Stalk, springs from the Root, and bears the flowers and fruit, but not the leaves. *Primula vulgaris*, the Primrose, *Engl. Bot. t.* 4, and *P. veris*, the Cowslip, *t.* 5, are examples of it. In the former the stalk is simple and single-flowered; in the latter subdivided, and many-flowered. It is either naked, as in *Narcissus*, *Engl. Bot. t.* 17, or scaly, as in *Tussilago Farfara*, *t.* 429. In others of this last genus, *t.* 430 and 431, the scales become leafy, and render the *Scapus* a proper *Caulis*.

The Stalk is spiral in *Cyclamen*, *Engl. Bot. t.* 548, and *Valisneria spiralis*, a wonderful plant, whose history will be detailed hereafter.

Linnæus believed* that a plant could not be increased by its *Scapus*; which in general is correct, but we have already recorded an exception, *p.* 86, in *Lachenalia tricolor*. The same great author has observed† that "a *Scapus* is only a species of *Pedunculus*." The term might therefore be spared, were it not found very commodious in constructing neat specific definitions of plants. If abolished, *Pedunculus radicalis*, a radical flower-stalk, should be substituted in its room.

4. PEDUNCULUS, the Flower-stalk, springs from the stem, and bears the flowers and fruit, not the leaves. *Pedicellus*, a partial flower-stalk, is the ultimate subdivision of a general one, as in the Cowslip, and *Saxifraga umbrosa*, *Engl. Bot. t.* 663.

The Flower-stalk is

Caulinus, cauline, when it grows immediately out of the main stem, especially of a tree, as in *Averrhoa Bilimbi*, *Rumph. Amboin. v.* 1. *t.* 36, the Indian substitute for our green gooseberries.

Rameus, growing out of a main branch, as in *Averrhoa Carambola*, *ibid. t.* 35, and *Eugenia malaccensis*, *Exot. Bot. t.* 61.

Axillaris, axillary, growing either from the bosom of a leaf, that is, between it and the stem, as

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* *MSS. in Phil. Bot.* 40. † *Ibid.*

Anchusa sempervirens, *Engl. Bot.* *t.* 45, and *Campanula Trachelium*, *t.* 12; or between a branch and the stem, as *Ruppia maritima*, *t.* 136.

Oppositifolius, opposite to a leaf, as *Geranium pyrenaicum*, *t.* 405, *G. molle*, *t.* 778, and *Sium angustifolium*, *t.* 139.

Internodis, proceeding from the intermediate part of a branch between two leaves, as in *Ehretia internodis*, *L'Heritier Stirp.* *t.* 24, *Solanum carolinense*, *Dill. Hort. Elth.* *t.* 259, and *indicum*, *t.* 260; but this mode of insertion is rare.

Gemmaceus, growing out of a leaf-bud, as the Barberry, *Berberis vulgaris*, *Engl. Bot.* *t.* 49.

Terminalis, terminal, when it terminates a stem or branch, as *Tulipa sylvestris*, *t.* 63, and *Centaurea Scabiosa*, *t.* 56.

Lateralis, lateral, when situated on the side of a stem or branch, as *Erica vagans*, *t.* 3.

Solitarius, solitary, either single on a plant, as in *Rubus Chamæmorus*, *t.* 716, or only one in the same place, as in *Antirrhinum spurium*, *t.* 691, and many common plants.

Aggregati Pedunculi, clustered flower-stalks, when several grow together, as in *Verbascum nigrum*, *t.* 59.

Sparsi, scattered, dispersed irregularly over the plant or branches, as *Linum perenne*, *t.* 40, and *Ranunculus sceleratus*, *t.* 681,

Uniflori, *biflori*, *triflori*, &c. bearing one, two, three, or more flowers, of which examples are needless.

Multiflori, many-flowered, as *Daphne Laureola*, *t.* 119.

When there is no Flower-stalk, the flowers are said to be *Sessiles*, sessile, as in *Centaurea Calcitrapa*, *t.* 125, and the Dodders, *t. 55* and 378.

The subject of inflorescence, or particular modes of flowering, will be explained in a future chapter.

5. **Petiolus.** The Footstalk, or Leaf-stalk. This term is applied exclusively to the stalk of a leaf, which is either simple, as in *Ranunculus parviflorus*, *Engl. Bot. t.* 120, *Sium angustifolium*, *t.* 139, and all simple leaves; or compound, as *Coriandrum sativum*, *t.* 67, and *Fumaria claviculata*, *t.* 103. In the latter the footstalks end in tendrils, and are called *Petioli cirriferi.*

This part is commonly channelled on the upper side. Sometimes it is greatly dilated and concave at the base, as in *Angelica sylvestris*, *t.* 1128.

The Footstalk bears the Flower-stalk in *Turnera ulmifolia*, *Linn. Hort. Cliff. t.* 10, *Menyanthes indica*, *Curt. Mag. t.* 658, and perhaps *Epimedium alpinum*, *Engl. Bot. t.* 438.

6. **Frons.** A Frond. In this the stem, leaf and fructification are united, or, in other words, the flowers and fruit are produced from the leaf itself, as in the

Fern tribe, *Scolopendrium vulgare*, *Engl. Bot. t.* 1150, *Polypodium vulgare*, *t.* 1149, *Aspidium*, *t.* 1458—1461, *Osmunda regalis*, *t.* 209, &c. It is also applied to the *Lichen* tribe, and others, in which the whole plant is either a crustaceous or a leafy substance, from which the fructification immediately proceeds. Linnæus considered Palm-trees as fronds, so far correctly as that they have not the proper stem of a tree, see *p.* 45; but they are rather perhaps herbs whose stalks bear the fructification. It must however be observed that the deposition of wood in ferns, takes place exactly as in palms.

The term frond is now used in the class *Cryptogamia* only.

7. Stipes, Stipe*, is the stem of a frond, which in ferns is commonly scaly. See the plates cited in the last section. The term is likewise applied to the stalk of a Fungus, as the Common Mushroom, *Agaricus campestris*, *Sowerby's Fungi*, *t.* 305.

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* Martyn, *Language of Botany*.

CHAPTER XIV.

OF BUDS.

GEMMA, a Bud, contains the rudiments of a plant, or of part of a plant, for a while in a latent state, till the time of the year and other circumstances favour their evolution. In the bud therefore the vital principle is dormant, and its excitability is accumulated. The closest analogy exists between buds and bulbs; and indeed the *Dentaria bulbifera*, *Engl. Bot. t.* 309, *Lilium bulbiferum*, *Jacq. Fl. Austr. t.* 226, and *Gerarde emac.* 193, with other similar plants, as mentioned *p.* 86, almost prove their identity.

Buds of trees or shrubs, destined for cold countries, are formed in the course of the summer in the bosoms of their leaves, and are generally solitary; but in the Blue-berried Honeysuckle, *Lonicera cærulea*, *Jacq. Fl. Austr. append. t.* 17, they grow one under another for three successive seasons, *f.* 24. The buds of the Plane-tree, *Platanus*, *Du Hamel Arb. v.* 2. 171, are concealed in the footstalk, which must be removed before they can be seen, and which they force off by their increase; so that no plant can have more truly and necessarily deciduous leaves than the Plane. Shrubs in general have no buds, neither have the trees of hot climates. Linnæus once thought the presence of buds might distinguish a tree from a shrub, but he was soon convinced of there being no real limits between them.

The situation of buds is necessarily like that of the leaves, alternate, opposite, &c. Trees with opposite leaves have three buds, those with alternate ones a solitary bud, at the top of each branch. *Du Hamel.*

Buds are various in their forms, but very uniform in the same species or even genus. They consist of scales closely enveloping each other, and enfolding the embryo plant or branch. Externally they have often an additional guard, of gum, resin or woolliness, against wet and cold. The Horse Chesnut, *Æsculus Hippocastanum*, now so common with us, though, as I have learnt from Mr. Hawkins*, a native of Mount Pindus in Arcadia, is a fine example of large and well-formed buds, *f.* 25; and some of the American Walnuts are still more remarkable.

It has been already remarked, *p.* 69, that buds resist cold only till they begin to grow: hence, according to the nature and earliness of their buds, plants differ in their powers of bearing a severe or variable climate.

Grew is elaborate on the forms of buds, and the arrangement of the spots apparent within them when cut transversely, which indicate the number and situation of their vessels. It was the character of this excellent man to observe every thing, without reference to any theory, and his book is a storehouse of facts relating to vegetation. Loefling, a favourite pupil of Linnæus, wrote, under the eye of his great teacher, an essay on this subject, published in the *Amœnitates Academicæ*, v. 2, in which the various forms of buds, and the different disposition of the leaves within them, are illustrated by numerous examples. The Abbé de Ramatuelle had taken up this subject with great zeal at Paris, about twenty years ago, but the result of his inquiries has not reached me.

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* See a note on this subject, which Mr. R. P. Knight has honoured with a place in the second edition of his poem on Landscape.

Dr. Darwin, *Phytologia, sect.* 9, has many acute observations on the physiology of buds, but he appears to draw the analogy too closely between them and the embryo of a seed, or the chick in the egg. By buds indeed, as we well know, plants are propagated, and in that sense each bud is a separate being, or a young plant in itself; but such propagation is only the extension of an individual, and not a reproduction of the species as by seed. Accordingly, all plants increased by buds, cuttings, layers or roots, retain precisely the peculiar qualities of the individual to which they owe their origin. If those qualities differ from what are common to the species, sufficiently to constitute what is called a variety, that variety is perpetuated through all the progeny thus obtained. This fact is exemplified in a thousand instances, none more notorious than the different kinds of Apples, all which are varieties of the common Crab, *Pyrus Malus, Engl. Bot. t.* 179; and

I cannot but assent to Mr. Knight's opinion, that each individual thus propagated has only a determinate existence, in some cases longer, in others shorter; from which cause many valuable varieties of apples and pears, known in former times, are now worn out, and others are dwindling away before our eyes. New varieties of Cape Geraniums, raised from seed in our greenhouses, are of still shorter duration, and can be preserved by cuttings for a few successive seasons only; yet several of these stand in our botanic works, with all the importance of real species. Gardeners know how many of the most hardy perennial herbs require to be frequently renewed from seed to exist in full vigour; and though others appear, to our confined experience, unlimited in that respect, we have many reasons to believe they are not so. Propagation by seeds is therefore the only true reproduction of plants, by which each species remains distinct, and all variations are effaced; for though new varieties may arise among a great number of seedling plants, it does not appear that such varieties owe their peculiarities to any that may have existed in the parent plants. How propagation by seed is accomplished will be explained in a future chapter, as well as the causes of some varieties produced by that means.

Mr. Knight, in the *Philosophical Transactions for* 1805, has shown that buds originate from the alburnum, as might indeed be expected. The trunks and branches of trees, and the knobs of genuine tuberous roots, like the potatoe, are studded with them; in which respect, as Professor Willdenow judiciously observes, *Principles of Botany*, *p.* 15, such roots essentially differ from bulbous ones, which last are themselves simple buds, and produce their shoots, as well as their offsets, either from the centre or from the base.

The contents of buds are different, even in different species of the same genus, as Willows. The buds of some produce leaves only, others flowers; while in other species the same bud bears both leaves and flowers. Different causes, depending on the soil or situation, seem in one case to generate leaf-buds, in another flower-buds. Thus the *Solandra grandiflora*, *Tr. of Linn. Soc. v.* 6. 99. *t.* 6, a Jamaica shrub, was for a number of years cultivated in the English stoves, and propagated extensively by cuttings, each plant growing many feet in length every season, from abundance of moisture and nourishment, without showing any signs of fructification. At length a pot of the *Solandra* was accidentally left without water in the dry stove at Kew; and in consequence of this unintentional neglect, the luxuriant growth of its branches was greatly checked, and a flower came forth at the extremity of each. By a similar mode of treatment the same effect has since frequently been produced. Several plants, especially with bulbous roots, which blossom abundantly in their native soils, have hitherto defied all the art of our gardeners to produce this desirable effect; yet future experience may possibly place it within our reach by some very simple means. In general, whatever checks the luxuriant production of leaf-buds, favours the formation of flowers and seeds. That variety, or perhaps species, of the Orange Lily, *Lilium bulbiferum*, which is most prolific in buds, seldom forms seeds, or even those organs of the flower necessary to their perfection. So likewise the seeds of Mints, a tribe of plants which increase excessively by roots, have hardly been detected by any botanist; and it is asserted by Doody in Ray's *Synopsis*, that when the elegant little *Ornithopus perpusillus*, *Engl. Bot.* t. 369, does not produce pods, it propagates itself by the grains or tubercles of its root, though in general the root is annual.

CHAPTER XV.

OF LEAVES, THEIR SITUATIONS, INSERTIONS, SURFACES, AND VARIOUS FORMS.

FOLIUM, the Leaf, is a very general, but not universal, organ of vegetables, of an expanded form, presenting a much greater surface to the atmosphere than all the other parts of the plant together. Its colour is almost universally green, its internal substance pulpy and vascular, sometimes very succulent, and its upper and under surfaces commonly differ in hue, as well as in kind or degree of roughness.

Leaves are eminently ornamental to plants from their pleasing colour, and the infinite variety as well as elegance of their forms. Their many œconomical uses to mankind, and the importance they hold in the scale of nature as furnishing food to the brute creation, are subjects foreign to our present purpose, and need not here be insisted upon. Their essential importance to the plant which bears them, and the curious functions by which they contribute to its health and increase, will presently be detailed at length. We shall first explain their different situations, insertions, forms, and surfaces, which are of the greatest possible use in systematical botany.

The leaves are wanting in many plants, called for that reason *plantæ aphyllæ*, as *Salicornia*, *Engl. Bot. t.* 415 and 1691, *Stapelia variegata*, *Curt. Mag. t.* 26, *glanduliflora*, *Exot. Bot. t.* 71, and all the species of that genus. In such cases the surface of the stem must perform all their necessary functions.

1. With respect to Situation and Position,

Folia radicalia, radical leaves, are such as spring from the root, like those of the Cowslip, *Engl. Bot. t.* 5, and *Anemone Pulsatilla*, *t.* 51.

Caulina, stem-leaves, grow on the stem, as in *Paris quadrifolia*, *t.* 7, *Polemonium cæruleum*, *t.* 14, &c.

Ramea, branch-leaves, sometimes differ from those of the main stem, and then require to be distinguished from them, as *Melampyrum arvense*, *t.* 53.

Alterna, *f.* 21, alternate leaves, stand solitarily on the stem or branches, spreading in different directions, as those of Borage, *t.* 36, and innumerable other plants.

Sparsa, *f.* 19, scattered irregularly, as in *Genista tinctoria*, *t.* 44, *Lilium chalcedonicum*, *Curt. Mag. t.* 30, and *bulbiferum*, *t.* 36.

Opposita, opposite to each other, as *Saxifraga oppositifolia*, *Engl. Bot. t.* 9, *Ballota nigra*, *t.* 46, &c.

Conferta, clustered, or crowded together, as those of *Trientalis europæa*, *t.* 15.

Bina, only two upon a plant or stem, as in the Snowdrop, *Galanthus nivalis*, *t.* 19, *Scilla bifolia*, *t.* 24, and *Convallaria majalis*, *t.* 1035.

Terna, three together, as *Verbena triphylla*, *Curt. Mag. t.* 367. The plants of Chili and Peru seem particularly disposed to this arrangement of their leaves.

Quaterna, *quina*, &c. when 4, 5, or more are so situated, as in various species of Heath, *Erica*.

Verticillata, whorled, is used to express several leaves growing in a circle round the stem, without a reference to their precise number, as in *Asperula cynanchica*, *Engl. Bot. t.* 33, and *odorata*, *t.* 755, which, with the genus *Galium*, and some others, are for this reason called *stellatæ*, star-leaved plants. Whorled leaves are also found in *Hippuris vulgaris*, *t.* 763, and many besides.

Fasciculata, *f.* 26, tufted, as in the Larch, *Pinus Larix*, *Lamb. Pin. t.* 35, the Cedar, and some others of that genus.

Imbricata, *f.* 27, imbricated, like tiles upon a house, as in the common Ling, *Erica vulgaris*, *Engl. Bot. t.* 1013, and *Euphorbia paralia*, *t.* 195.

Decussata, *f.* 28, decussated, in pairs alternately crossing each other, as *Veronica decussata*, *Curt. Mag. t.* 242, and *Melaleuca thymifolia*, *Exot. Bot. t.* 36.

Disticha, *f.* 29, two-ranked, spreading in two directions, and yet not regularly opposite at their insertion, as *Pinus canadensis*, *Lamb. Pin. t.* 32, and the Yew, *Taxus baccata*, *Engl. Bot. t.* 746.

Secunda, *f.* 30, unilateral, or leaning all towards one side, as *Convallaria multiflora*, *t.* 279.

Adpressa, close-pressed to the stem, as *Xeranthemum sesamoides*, *Curt. Mag. t.* 425.

Verticalia, perpendicular, both sides at right angles with the horizon, as *Lactuca Scariola*, *Engl. Bot. t.* 268.

Erecta, upright, forming a very acute angle with the stem, as *Juncus articulatus*, *t.* 238.

Patentia, spreading, forming a moderately acute angle with the stem or branch, as *Atriplex portulacoides*, *t.* 261.

Horizontalia, horizontal, or *patentissima*, spreading in the greatest possible degree, as *Gentiana campestris*, *t.* 237.

Reclinata, inclining downward, as *Leonurus Cardiaca*, *t.* 286.

Recurva, or *reflexa*, curved backward, as *Erica retorta*, *Curt. Mag. t.* 362.

Incurva, or *inflexa*, curved inward, as *Erica empetrifolia*, *t.* 447.

Obliqua, twisted, so that one part of each leaf is vertical, the other horizontal, as *Fritillaria obliqua*, *t.* 857, and some of the large *Proteæ*.

Resupinata, reversed, when the upper surface is turned downward, as *Pharus latifolius*, *Browne's*

Jamaica, *t.* 38, *Linn. Mss.*, and *Alstrœmeria pelegrina*, *Curt. Mag. t.* 139.

Depressa, radical leaves pressed close to the ground, as *Plantago media*, *Engl. Bot. t.* 1559, and *P. Coronopus*, *t.* 892. The same term applied to stem-leaves, expresses their shape only, as being vertically flattened, in opposition to *compressa.*

Natantia, floating, on the surface of the water, as *Nymphæa alba*, *t.* 160, *Potamogeton natans*, *t.* 1822, and many water plants.

Demersa, *immersa*, or *submersa*, plunged under water, as *Potamogeton perfoliatum*, *t.* 168, *Hottonia palustris*, *t.* 364, *Lobelia Dortmanna*, *t.* 140, and the lower leaves of *Ranunculus aquatilis*, *t.* 101, while its upper are *folia natantia.*

Emersa, raised above the water, as the upper leaves, accompanying the flowers, of *Myriophyllum verticillatum*, *t.* 218, while its lower ones are *demersa.*

2. By Insertion is meant the mode in which one part of a plant is connected with another.

Folia petiolata, leaves on footstalks, are such as are furnished with that organ, whether long or short, simple or compound, as *Verbascum nigrum*, *Engl. Bot. t.* 59, *Thalictrum minus*, *t.* 11, *alpinum*, *t.* 262, &c.

Peltata, *f.* 31, peltate, when the footstalk is inserted into the middle of the leaf, like the arm of a man holding a shield, as in the Common Nasturtium, *Tropæolum majus*, *Curt. Mag. t.* 23, *Drosera peltata*, *Exot. Bot. t.* 41, *Cotyledon Umbilicus*, *Engl. Bot. t.* 325, *Hydrocotyle vulgaris*, *t.* 751, and the noble *Cyamus Nelumbo*, *Exot. Bot. t.* 31, 32.

Sessilia, sessile, are such as spring immediately from the stem, branch or root, without any footstalk, as in *Anchusa sempervirens*, *Engl. Bot. t.* 45, and *Pinguicula vulgaris*, *t.* 70.

Amplexicaulia, *f.* 32, clasping the stem with their base, as the upper leaves of *Glaucium luteum*, *t.* 8, *Gentiana campestris*, *t.* 237, and *Humea elegans*, *Exot. Bot. t.* 1.

Connata, *f.* 17, connate, united at their base, as *Chlora perfoliata*, *Engl. Bot. t.* 60, whose leaves are *connato-perfoliata*.

Perfoliata, *f.* 33, perfoliate, when the stem runs through the leaf, as *Bupleurum rotundifolium*, *t.* 99, and the *Uvulariæ*, *Exot. Bot. t.* 49, 50, 51.

Vaginantia, *f.* 34, sheathing the stem or each other, as in most Grasses; see *Phleum alpinum*, *Engl. Bot. t.* 519, and *Arundo arenaria*, *t.* 520. The same character is found in many of the Orchis tribe, as *Satyrium albidum*, *t.* 505.

Equitantia, *f.* 35, equitant, disposed in two opposite rows and clasping each other by their compressed base, as in *Narthecium ossifragum*, *t.* 535, and the genus *Iris*; also *Witsenia corymbosa*, *Exot. Bot. t.* 68, and *Dilatris corymbosa*, *t.* 16.

Decurrentia, *f.* 36, decurrent, running down the stem or branch in a leafy border or wing, as *Onopordum Acanthium*, *Engl. Bot. t.* 977, *Carduus tenuiflorus*, *t.* 412, and many other Thistles, also the Great Mullein, *Verbascum Thapsus*, *t.* 549, and Comfrey, *Symphytum officinale*, *t.* 817.

Florifera, *f.* 37, flower-bearing, when flowers grow out of the disk or margin of any leaf, as in *Ruscus aculeatus*, *t.* 560, *Xylophylla latifolia*, and *X. falcata*, *Andr. Repos. t.* 331. This is equivalent to a frond in the class *Cryptogamia*; see *p.* 103.

3. With regard to form, Leaves are either *simplicia*, simple, like those of Grasses, Orchises, Lilies, and many other plants, *Ballota nigra*, *Engl. Bot. t.* 46, and *Berberis vulgaris*, *t.* 49; or *composita*, compound, as in most Umbelliferous plants, Parsley, Hemlock, &c.; also Roses, *Engl. Bot. t.* 990—992.

In compound leaves the footstalk is either simple, as in the instances last quoted, and *Sium angustifolium*, *t.* 139; or compound, like those of *Selinum palustre*, *t.* 229, and *Thalictrum majus*, *t.* 611.—In simple leaves the footstalk, if present, must of course be simple, while in compound ones it must always be present, though not always subdivided.

Simple Leaves are either *integra*, undivided, as those of Grasses and Orchises; or *lobata*, lobed, like the Vine, the Thistle, most kinds of Cranesbill, as *Geranium pratense*, *Engl. Bot. t.* 404, &c.

Leaves are frequently undivided and lobed on the same plant, as the Hop, *Engl. Bot. t.* 427.

4. The following are the most remarkable forms of Simple Leaves, considering their outline only.

Orbiculatum, *f.* 38, a circular or orbicular leaf, whose length and breadth are equal, and the circumference an even circular line. Precise examples of this are scarcely to be found. Some species of *Piper* approach it, and the leaf of *Hedysarum styracifolium* is perfectly orbicular, except a notch at the base.

Subrotundum, *f.* 39, roundish, as *Pyrola*, *Engl. Bot. t.* 146, 158 and 213, and many other plants.

Ovatum, *f.* 40, ovate, of the shape of an egg cut lengthwise, the base being rounded and broader than the extremity, a very common form of leaves, as *Urtica pilulifera*, *t.* 148, and *Vinca major*, *t.* 514.

Obovatum, *f.* 41, obovate, of the same figure with the broader end uppermost, as those of the Primrose, *t.* 4, and the Daisy, *t.* 424. Linnæus at first used the words *obversè ovatum*.

Ellipticum, *f.* 42, or *ovale*, elliptical or oval, of a similar form to the foregoing, but of equal breadth at each end, as in the Lily of the Valley, and other *Convallariæ*, *t.* 1035, 279 and 280.

Oblongum, oblong, three or four times longer than broad. This term is used with great latitude, and serves chiefly in a specific character to contrast a leaf which has a variable, or not very decided, form, with others that are precisely round, ovate, linear, &c.

Spatulatum, *f.* 43, spatulate, of a roundish figure tapering into an oblong base, as in *Silene Otites*, *Fl. Brit.*, *Engl. Bot. t.* 85.

Cuneiforme, *f.* 44, wedge-shaped, broad and abrupt at the summit, and tapering down to the base, as in *Saxifraga cuneifolia*.

Lanceolatum, *f.* 45, lanceolate, of a narrow oblong form, tapering towards each end, very common, as *Tulipa sylvestris*, *Engl. Bot. t.* 63, *Lithospermum purpuro-cæruleum*, *t.* 117, *Plantago lanceolata*, *t.* 507, many Willows, &c.

Lineare, *f.* 46, linear, narrow with parallel sides, as those of most Grasses; also *Gentiana Pneumonanthe*, *t.* 20, and *Narcissus Pseudo-narcissus*, *t.* 17.

Acerosum, *f.* 47, needle-shaped, linear and evergreen, generally acute and rigid, as in the Fir, *Pinus*, Juniper, *Juniperus communis*, *t.* 1100, and Yew, *Taxus baccata*, *t.* 746. Linnæus observes, *Phil. Bot.* 219, that this kind of leaf has, for the most part, a joint at its union with the branch.

Triangulare, *f.* 48, triangular, having three prominent angles, without any reference to their measurement or direction, as in the genus *Chenopodium*, *Cochlearia danica*, *t.* 696, and some leaves of the Ivy.

Quadrangulare, *f.* 49, with four angles, as the Tulip-tree, *Liriodendrum tulipifera*, *Sm. Ins. of Georgia*, *t.* 102, *Curt. Mag. t.* 275.

Quinquangulare, *f.* 19, with five angles, as some Ivy leaves, &c.

Deltoides, *f.* 50, trowel-shaped or deltoid, having three angles, of which the terminal one is much further from the base than the lateral ones, as *Chenopodium Bonus-Henricus*, *Engl. Bot. t.* 1033, and some leaves of *Cochlearia danica.* A wrong figure is quoted for this in *Philosophia Botanica*, which has caused much confusion.

Rhombeum, *f.* 51, rhomboid, or diamond-shaped, approaching to a square, as *Chenopodium olidum*, *t.* 1034, *Trapa natans*, *Camer. Epit.* 715, and *Trillium erectum*, *Curt. Mag. t.* 470.

Reniforme, *f.* 52, kidney-shaped, a short, broad, roundish leaf, whose base is hollowed out, as

Asarum europæum, *Engl. Bot. t.* 1083, and *Sibthorpia europæa*, *t.* 649.

Cordatum, *f.* 53, heart-shaped, according to the vulgar idea of a heart; that is, ovate hollowed out at the base, as *Tamus communis*, *t.* 91.

Lunulatum, *f.* 54, crescent-shaped, like a half-moon, whether the points are directed towards the stalk, or from it, as *Passiflora lunata*, *Sm. Ic. Pict. t.* 1.

Sagittatum, *f.* 55, arrow-shaped, triangular, hollowed out very much at the base, as *Sagittaria sagittifolia*, *Engl. Bot. t.* 84, and *Rumex Acetosa*, *t.* 127.

Sometimes the posterior angles are cut off, as in *Convolvulus sepium*, *t.* 313.

Hastatum, *f.* 56, halberd-shaped, triangular, hollowed out at the base and sides, but with spreading lobes, as *Rumex Acetosella*, *t.* 1674, *Antirrhinum Elatine*, *t.* 692, and the upper leaves of *Solanum Dulcamara*, *t.* 565.

Panduriforme, *f.* 57, fiddle-shaped, oblong, broad at the two extremities and contracted in the middle, as the Fiddle Dock, *Rumex pulcher*, *t.* 1576.

Runcinatum, *f.* 58, runcinate, or lion-toothed, cut into several transverse, acute segments, pointing backwards, as the Dandelion, *Leontodon Taraxacum*, *t.* 510.

Lyratum, *f.* 59, lyrate, or lyre-shaped, cut into several transverse segments, gradually larger towards the extremity of the leaf, which is rounded, as *Erysimum Barbarea, t.* 443.

Fissum, f. 60, cloven, when the margins of the fissures and segments are straight, as in the Gingko-tree, *Salisburia adiantifolia.*

Bifidum, trifidum, multifidum, &c. express the number of the segments.

Lobatum, f. 61, lobed, when the margins of the segments are rounded, as in *Anemone Hepatica, Curt. Mag. t.* 10.

Bilobum, trilobum, &c., according to the number of the lobes.

Sinuatum, f. 62, sinuated, cut into rounded or wide openings, as *Statice sinuata, t.* 71, and *Virgilia helioides, Exot. Bot. t.* 37.

Partitum, f. 63, deeply divided, nearly to the base, as *Helleborus viridis, Engl. Bot. t.* 200.

Bipartitum, tripartitum, multipartitum, according to the number of the divisions.

Laciniatum, f. 64, laciniated, cut into numerous irregular portions, as *Ranunculus parviflorus, t.* 120, and *Geranium columbinum, t.* 259.

Incisum, and *Dissectum,* cut, are nearly synonymous with the last.

It is remarked by Linnæus that aquatic plants have their lower, and mountainous ones their upper, leaves most divided, by which they better resist the action of the stream in one case, and of wind in the other. Probably these actions are in some measure the causes of such configurations.

Palmatum, *f.* 65, palmate, cut into several oblong, nearly equal segments, about half way, or rather more, towards the base, leaving an entire space like the palm of the hand, as *Passiflora cærulea*, *Curt. Mag. t.* 28.

Pinnatifidum, *f.* 66, pinnatifid, cut transversely into several oblong parallel segments, as in *Ipomopsis*, *Exot. Bot. t.* 13, 14, *Bunias Cakile*, *Engl. Bot. t.* 231, *Lepidium didymum*, *t.* 248, *petræum*, *t.* 111, and *Myriophyllum verticillatum*, *t.* 218.

Bipinnatifidum, *f.* 67, doubly pinnatifid, as *Papaver Argemone*, *t.* 643, and *Eriocalia major*, *Exot. Bot. t.* 78.

Pectinatum, *f.* 68, pectinate, is a pinnatifid leaf, whose segments are remarkably narrow and parallel, like the teeth of a comb, as the lower leaves of *Myriophyllum verticillatum*, and those of *Hottonia palustris*, *Engl. Bot. t.* 364.

Inæquale, *f.* 69, unequal, sometimes called oblique, when the two halves of the leaf are unequal in dimensions, and their bases not parallel, as in *Eucalyptus resinifera*, *Exot. Bot. t.* 84, and most species of that genus, as well as of *Begonia*.

5. The Terminations of Leaves are various.

Folium truncatum, *f.* 49, an abrupt leaf, has the extremity cut off, as it were, by a transverse line, as *Liriodendrum tulipifera*, *Curt. Mag. t.* 275.

Præmorsum, *f.* 70, jagged-pointed, very blunt, with various irregular notches, as in Dr. Swartz's genus *Aërides*, comprehended under the *Epidendrum* of Linnæus. See *E. tessellatum*, *Roxb. Pl. of Coromandel*, *t.* 42, and *præmorsum*, *t.* 43.

Retusum, *f.* 71, retuse, ending in a broad shallow notch, as *Rumex digynus*, *Engl. Bot. t.* 910.

Emarginatum, *f.* 72, emarginate, or nicked, having a small acute notch at the summit, as the Bladder Senna, *Colutea arborescens*, *Curt. Mag. t.* 81.

Obtusum, *f.* 39, blunt, terminating in a segment of a circle, as the Primrose, *Engl. Bot. t.* 4, Snowdrop, *t.* 19, *Hypericum quadrangulum*, *t.* 370, and *Linum catharticum*, *t.* 382.

Acutum, *f.* 51, sharp, ending in an acute angle, which is common to a great variety of plants, as Ladies' Slipper, *t.* 1, *Campanula Trachelium*, *t.* 12, and *Linum angustifolium*, *t.* 381.

Acuminatum, *f.* 73, pointed, having a taper or awl-shaped point, as *Arundo Phragmites*, *t.* 401, and *Scirpus maritimus*, *t.* 542.

Obtusum cum acumine, *f.* 74, blunt with a small point, as *Statice Limonium*, *t.* 102.

Mucronatum or *Cuspidatum*, *f.* 75, sharp-pointed, tipped with a rigid spine, as in the Thistles, *t.* 107, *t.* 386, &c., *Ruscus aculeatus*, *t.* 560, and *Melaleuca nodosa*, *Exot. Bot. t.* 35.

Cirrosum, *f.* 76, cirrose, tipped with a tendril, as in *Gloriosa superba*, *Andr. Repos. t.* 129.

6. The different Margins of Leaves are characterized as follows.

Folium integerrimum, *f.* 39, an entire leaf, as in the Orchis and Lily tribe, as well as *Polygala vulgaris*, *Engl. Bot. t.* 76, *Daphne Laureola*, *t.* 119, &c.

This term is opposed to all kinds of teeth, notches, or incisions. It regards solely the margin of a leaf; whereas *integrum*, *p.* 117, respects its whole shape, and has nothing to do with the margin. English writers who translate the one *entire*, and the other *very entire*, are therefore incorrect.

Spinosum, *f.* 77, spinous, beset with prickles, as *Carduus lanceolatus*, *t.* 107, and *Eryngium campestre*, *t.* 57. The veins are spinous in *Solanum Pyracantha*, *Exot. Bot. t.* 64, &c.

Inerme, *f.* 71, unarmed, is opposed to spinous.

Ciliatum, *f.* 78, fringed, bordered with soft parallel hairs, as *Galium cruciatum*, *Engl. Bot. t.* 143.

Cartilagineum, cartilaginous, hard and horny, as *Saxifraga callosa*, *Dicks. Dr. Pl. n.* 63.

Dentatum, *f.* 79, toothed, beset with projecting, horizontal, rather distant teeth of its own substance, as *Atriplex laciniata*, *Engl. Bot. t.* 165, *Hypochæris maculata*, *t.* 225, and the lower leaves of *Centaurea Cyanus*, *t.* 277; also *Nymphæa Lotus*, *Curt. Mag. t.* 797.

Serratum, *f.* 80, serrated, when the teeth are sharp, and resemble those of a saw, pointing towards the extremity of the leaf. Examples of this are frequent, as *Urtica*, *t.* 148 and 1236, *Rosa*, *t.* 992, &c., *Comarum palustre*, *t.* 172, and *Senecio paludosus*, *t.* 650; also *Dillenia indica*, *Exot. Bot. t.* 2. Some leaves are doubly serrated, *duplicato-serrata*, having a series of smaller serratures intermixed with the larger, as *Mespilus grandiflora*, *t.* 18, and *Campanula Trachelium*, *Engl. Bot. t.* 12.

Serrulatum, *f.* 63, minutely serrated, is used when the teeth are very fine, as in *Polygonum amphibium*, *t.* 436, and *Empleurum serrulatum*, *Exot. Bot. t.* 63.

Crenatum, *f.* 81, notched, or crenate, when the teeth are rounded, and not directed towards either end of the leaf, as in Ground-Ivy, *Glechoma hederacea*, *t.* 853, *Chrysosplenium*, *t.* 54 and 490, and *Sibthorpia europæa*, *t.* 649. In *Saxifraga Geum*, *t.* 1561, the leaves are sharply crenate. In the two British species of *Salvia*, *t.* 153 and 154, the radical leaves are doubly crenate, *f.* 82.

Erosum, *f.* 83, jagged, irregularly cut or notched, especially when otherwise divided besides, as in *Senecio squalidus*, *t.* 600.

Repandum, *f.* 84, wavy, bordered with numerous minute angles, and small segments of circles alternately, as *Menyanthes nymphæoides*, *t.* 217, and *Inula dysenterica*, *t.* 1115.

Glandulosum, glandular, as *Hypericum montanum*, *t.* 371, and the Bay-leaved Willow, *Salix pentandra*.

Revolutum, revolute, when the margin is turned or rolled backwards, as *Andromeda polifolia*, *t.* 713, and *Tetratheca glandulosa*, *Exot. Bot. t.* 21.

Linnæus seems originally to have applied this term to the rolling of the whole leaf backwards, as in *Solidago Virgaurea*, *Engl. Bot. t.* 301, meaning to use the expression *margine revolutum* when the margin was intended; but this latter case being extremely frequent and the other very rare, he fell into the practice of using *revolutum* simply for the margin.

Involutum, involute, the reverse of the preceding, as in *Pinguicula*, *t.* 70 and 145.

Conduplicatum, folded, when the margins are brought together in a parallel direction, as in *Roscoea purpurea*, *Exot. Bot. t.* 108.

7. Terms expressive of different kinds of surface, applying equally to the leaf and to the stem, have been already explained, *p.* 96. To these may be added the following, chiefly appropriated to leaves.

Punctatum, dotted; either superficially as in *Rho-*

dodendrum punctatum, Andr. Repos. t. 36, and *Melaleuca linarifolia, Exot. Bot. t.* 56; or through the substance, as in *Hypericum perforatum, Engl. Bot. t.* 295, and the whole natural order to which the Orange and Lemon belong.

Rugosum, rugged, when the veins are tighter than the surface between them, causing the latter to swell into little inequalities, as in various species of Sage, *Salvia*. See *Flora Græca;* also *Teucrium Scorodonia, Engl. Bot. t.* 1543.

Bullatum, blistery, is only a greater degree of the last, as in the Garden Cabbage, *Brassica oleracea.*

Plicatum, f. 85, plaited, when the disk of the leaf, especially towards the margin, is acutely folded up and down, as in Mallows, and *Alchemilla vulgaris, Engl. Bot. t.* 597, where, however, the character is but obscurely expressed.

Undulatum, f. 86, undulated, when the disk near the margin is waved obtusely up and down, as *Reseda lutea, t.* 321, and *Ixia crispa* (more properly *undulata**) *Curt. Mag. t.* 599.

Crispum, f. 87, curled, when the border of the leaf becomes more expanded than the disk, so as to grow elegantly curled and twisted, which Linnæus considers as a disease. *Malva crispa, Ger. em.* 931, is an example of it, and may probably be a variety of *M. verticillata, Jacq. Hort. Vind. v.* 1. *t.* 40.

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* *Salisb. Hort.* 37.

Concavum, hollow, depressed in the middle, owing to a tightness in the border, as *Cyamus Nelumbo*, *Exot. Bot. t.* 32.

Venosum, *f.* 88, veiny, when the vessels by which the leaf is nourished are branched, subdivided, and more or less prominent, forming a network over either or both its surfaces, as *Cratægus*, or rather *Pyrus*, *torminalis*, *Engl. Bot. t.* 298, and *Verbascum Lychnitis*, *t.* 58.

Nervosum, *f.* 89, or *Costatum*, ribbed, when they extend in simple lines from the base to the point, as in *Cypripedium Calceolus*, *t.* 1, the *Convallariæ*, *t.* 279 and 280, *Stratiotes alismoides*, *Exot. Bot. t.* 15, and *Roxburghia viridiflora*, *t.* 57. The greater clusters of vessels are generally called *nervi* or *costæ*, nerves or ribs, and the smaller *venæ*, veins, whether they are branched and reticulated, or simple and parallel.

Avenium, veinless, and *Enerve*, ribless, are opposed to the former.

Trinerve. *f.* 90, three-ribbed, is applied to a leaf that has three ribs all distinct from the very base, as well as unconnected with the margin, in the manner of those many-ribbed leaves just cited; see *Blakea trinervis**, *Curt. Mag. t.* 451.

Basi trinerve, *f.* 91, three-ribbed at the base, is when the base is cut away close to the lateral ribs, as in Burdock, *Arctium Lappa*, *Engl. Bot.* *t.* 1228, *Tussilago*, *t.* 430 and 431, and the Great Annual Sunflower.

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* Authors incorrectly use the termination *trinervius*, *trinervia*, &c. for the more classical *trinervis*, *trinerve*, *enervis*, *enerve*.

Triplinerve, *f.* 92, triply-ribbed, when a pair of large ribs branch off from the main one above the base, which is the case in many species of Sunflower or *Helianthus*, *Laurus Cinnamomum* and *Camphora*, as well as *Blakea triplinervis*, *Aublet Guian. t.* 210.

Coloratum, coloured, expresses any colour in a leaf besides green, as in *Arum bicolor*, *Curt. Mag.* *t.* 820, *Amaranthus tricolor*, and others of that genus, *Justicia picta*, *Hedysarum pictum*, *Jacq. Ic. Rar. t.* 567, *Tradescantia discolor*, *Sm. Ic. Pict. t.* 10, *Pulmonaria officinalis*, *Engl. Bot.* *t.* 118.

Variegatum, variegated, is applied to a sort of variety or disease, by which leaves become irregularly blotched with white or yellow, like those of Striped Grass, *Arundo colorata*, *Fl. Brit.*; as also the Elder, the *Mentha rotundifolia*, *Engl. Bot. t.* 446, and the *Aucuba japonica*, which last is not known in our gardens in its natural green state.

Nudum, naked, implies that a leaf is destitute of all kinds of clothing or hairiness, as in the genus *Orchis*. *Nudus* applied to a stem means that it bears no leaves, and to a flower that it has no calyx.

8. The following terms express the substance, peculiar configuration, or any other remaining circumstances of leaves, not already explained.

Teres, *f.* 93, cylindrical, as those of *Conchium gibbosum*, *White's Voyage*, *t.* 22. *f.* 2; see *Cavanilles Icones*, *t.* 533 and 534.

Semicylindraceum, *f.* 94, semicylindrical, flat on one side, as *Salsola fruticosa*, *Engl. Bot.* *t.* 635, and *Chenopodium maritimum*, *t.* 633.

Subulatum, *f.* 95, awlshaped, tapering from a thickish base to a point, as *Salsola Kali*, *t.* 634.

Tubulosum, tubular, hollow within, as *Allium Cepa*, the Common Onion. The leaf of *Lobelia Dortmanna*, *Engl. Bot.* *t.* 140, is very peculiar in consisting of a double tube, *f.* 96.

Carnosum, *f.* 98, fleshy, of a thick pulpy substance, as in all those called succulent plants, *Crassula lactea*, *Exot. Bot.* *t.* 33, *Aloe*, *Sedum*, Mesembryanthemum, &c. See *Sempervivum tectorum*, *Engl. Bot.* *t.* 1320.

Gibbum, gibbous, swelling on one side or both, from excessive abundance of pulp, as *Aloe retusa*, *Curt. Mag.* *t.* 455.

Compressum, *f.* 98, compressed, flattened laterally, as *Mesembryanthemum uncinatum*, *Dill. Elth.* *t.* 193, and *acinaciforme*, *t.* 211.

Depressum, depressed, flattened vertically, as *M. linguiforme*, *t.* 183—185. See *p.* 114.

Canaliculatum, *f.* 97, channelled, having a longitudinal furrow, as *M. pugioniforme*, *t.* 210, *Plantago maritima*, *Engl. Bot. t.* 175, and *Narcissus poeticus*, *t.* 275.

Carinatum, keeled, when the back is longitudinally prominent, as *Narcissus biflorus*, *t.* 276.

Ensiforme, sword-shaped, is a two-edged leaf, tapering to a point, slightly convex on both surfaces, neither of which can properly be called upper or under, as in most of the genus *Iris*. See *Curt. Mag. t.* 671, *t.* 9, &c., and *Fl. Græc. t.* 39 and 40.

Anceps, two-edged, is much the same as the last.

Acinaciforme, cimeter-shaped, compressed, with one thick and straight edge, the other thin and curved, as *Mesembryanthemum acinaciforme* above mentioned.

Dolabriforme, *f.* 98, hatchet-shaped, compressed, with a very prominent dilated keel, and a cylindrical base, as *M. dolabriforme*, *Dill. Elth. t.* 191, *Curt. Mag. t.* 32.

These two last terms might well be spared, as they seem contrived only for the plants in question, and indeed are not essentially distinct from each other.

Trigonum, *f.* 99, three-edged, having three longitudinal sides and as many angles, like *M. deltoides*, *Dill. Elth. t.* 195, *Linn. Phil. Bot. t.* 1, *f.* 58. Linnæus has erroneously referred to this figure to illustrate his term *deltoides*; misled, as it should seem, by the name of the plant to which it belongs; but his definition is foreign to the purpose, see *p.* 119, and alludes to the outline of a flat leaf.

Triquetrum differs from *trigonum* only in being used by Linnæus for a three-sided awl-shaped leaf, as *M. emarginatum, Dill. Elth. t.* 197, *f.* 250, and *bicolorum, t.* 202, also *Saxifraga burseriana.*

Tetragonum, f. 100, four-edged, having four prominent angles, as *Iris tuberosa, Fl. Græc. t.* 41.

Lingulatum, tongue-shaped, of a thick, oblong, blunt figure, generally cartilaginous at the edges, as *Mesembryanthemum linguiforme, Dendrobium linguiforme, Exot. Bot. t.* 11, and several species of *Saxifraga,* as *S. mutata, Curt. Mag. t.* 351, *S. Cotyledon,* &c.

Membranaceum, membranous, of a thin and pliable texture, as in *Aristolochia Sipho, t.* 534, *Rubus odoratus, t.* 323, *Magnolia purpurea, t.* 390, &c.

Coriaceum, leathery, thick, tough and somewhat rigid, as *Magnolia grandiflora,* and *Hydrangea hortensis, Sm. Ic. Pict. t.* 12, *Curt. Mag. t.* 438.

Sempervirens, evergreen, permanent through one, two, or more winters, so that the branches are never stripped, as the Ivy, the Fir, the Cherry Laurel, the Bay, &c.

Deciduum, deciduous, falling off at the approach of winter, as in most European trees and shrubs.

Alienatum, f. 101, alienated, when the first leaves of a plant give place to others totally different from them and from the natural habit of the genus, as in many *Mimosæ* of New Holland; see *M. verticillata*, *Curt. Mag. t.* 110, and *myrtifolia*, *t.* 302; also *Lathyrus Nissolia*, *Engl. Bot. t.* 112.

Cucullatum, *f.* 102, hooded, when the edges meet in the lower part, and expand in the upper, as those of the curious genus *Sarracenia*. See *Curt. Mag. t.* 780 and 849, and *S. adunca*, *Exot. Bot. t.* 53.

Appendiculatum, *f.* 103, furnished with an additional organ for some particular purpose not essential to a leaf, as *Dionæa muscipula*, *Curt. Mag. t.* 785, cultivated very successfully by Mr. Salisbury, at *Brompton*, whose leaves each terminate in a pair of toothed irritable lobes, that close over and imprison insects; or *Nepenthes distillatoria*, *Rumph. Amboin. v.* 5. *t.* 59, *f.* 2, the leaf of which bears a covered pitcher, full of water. *Aldrovanda vesiculosa*, and our *Utriculariæ*, *Engl. Bot. t.* 253, 254, have numerous bladders attached to the leaves, which seem to secrete air, and float the plants.

Many of the preceding terms applied to leaves are occasionally combined, to express a form between the two, as *ovato-lanceolatum*, lanceolate inclining to ovate, or *elliptico-lanceolatum*, like the Privet, *Engl. Bot. t.* 764. When shape, or any other character, cannot be precisely defined, *sub* is prefixed to the term used, as *subrotundum*, roundish, *subsessile*, not quite destitute of a footstalk, to which is equavalent *subpetiolatum*, obscurely stalked. By the judicious use of such means, all necessary precision is attained. It is to be wished that authors were always uniform and consistent, at least with themselves, in the application of terms; but as Linnæus, the father of accurate botanical phraseology, very frequently misapplies his own terms, it is perhaps scarcely to be avoided. I have observed botanists most critical in theory, to be altogether deficient in that characteristic phraseology, that power of defining, which bears the stamp of true genius, and which renders the works of Linnæus so luminous in despite of incidental errors. Perhaps no mind, though ever so intent on the subject, can retain all the possible terms of description and their various combinations, for ready use at any given moment. There are few natural objects to which a variety of terms are not equally applicable in description, so that no two writers would exactly agree in their use. Neither is Nature herself so constant as not perpetually to elude our most accurate research. Happy is that naturalist who can seize at a glance what is most characteristic and permanent, and define all that is essential, without trusting to fallacious, though ever so specious, distinctions!

9. *Folia composita*, compound leaves, consist of two or any greater number of *foliola*, leaflets, connected by a common footstalk.

Folium articulatum, *f.* 104, a jointed leaf, is when one leaflet, or pair of leaflets, grows out of the summit of another, with a sort of joint, as in *Fagara tragodes*, *Jacq. Amer. t.* 14.

Digitatum, *f.* 22, digitate or fingered, when several leaflets proceed from the summit of a common footstalk, as *Potentilla verna*, *Engl. Bot. t.* 37, *reptans*, *t.* 862, and *Alchemilla alpina*, *t.* 244.

Binatum, *f.* 105, binate, is a fingered leaf consisting of only two leaflets, as in *Zygophyllum*, *Curt. Mag. t.* 372,

Ternatum, *f.* 106, ternate, consists of three leaflets, as *Fagonia cretica*, *t.* 241, and the genus *Trifolium*, Trefoil. See *Engl. Bot. t.* 190, &c.

Quinatum, quinate, of five leaflets, as *Potentilla alba*, *t.* 1384, *reptans*, *t.* 862, &c.

Pinnatum, pinnate, when several leaflets proceed laterally from one footstalk, and imitate a pinnatifid leaf, *p.* 122. This is of several kinds.

cum impari, *f.* 116, with an odd, or terminal, leaflet, as in Roses, and Elder, also *Polemonium cæruleum*, *Engl. Bot. t.* 14, and *Hedysarum Onobrychis*, *t.* 96,

cirrosum, *f.* 115, with a tendril, when furnished with a tendril in place of the odd leaflet, as the Pea and Vetch tribe; *Pisum maritimum*, *t.* 1046, *Lathyrus palustris*, *t.* 169, *Vicia sativa*, *t.* 334.

abrupte, *f.* 101, abruptly, without either a terminal leaflet or a tendril, as *Cassia Chamæcrista*, *Curt. Mag. t.* 107, and the genus *Mimosa*. See

M. pudica, the Common Sensitive-plant. This form of leaf is much more uncommon than the *impari-pinnatum*, and we have no perfect example of it among British plants. The nearest approach to it is the genus *Orobus*, whose leaves have only the rudiments of a tendril. A truly wonderful variety of the *Orobus sylvaticus*, *Engl. Bot. t.* 518, with large simple leaves, has been found in Wales.

opposité, oppositely, when the leaflets are opposite, or in pairs, as Saint-foin, *t.* 96, Roses, *Sium angustifolium*, *t.* 139, &c.

alternatìm, alternately, when they are alternate, as *Vicia dumetorum (Cracca sylvatica) Riv. Pent. Irr. t.* 51, and occasionally in our *V. sativa*, *lutea*, &c.

interrupté, *f.* 107, interruptedly, when the principal leaflets are ranged alternately with an intermediate series of smaller ones, as *Spiræa Filipendula*, *Engl. Bot. t.* 284, *S. Ulmaria*, *t.* 960, and *Potentilla anserina*, *t.* 861.

articulaté, jointedly, with apparent joints in the common footstalk, as *Weinmannia pinnata*.

decursivé, decurrently, when the leaflets are decurrent, as *Eryngium campestre*, *Engl. Bot. t.* 57, and *Potentilla fruticosa*, *t.* 88.

lyrato, *f.* 108, in a lyrate manner, having the terminal leaflet largest, and the rest gradually smaller as they approach the base, like *Erysimum præcox*, *t.* 1129, and, with intermediate smaller leaflets, *Geum rivale*, *t.* 106; also the Common Turnip. Such leaves are usually denominated lyrate in common with those properly so called (whose shape is simple, and not formed of separate leaflets); nor is this from inaccuracy in botanical writers. The reason is, that these two kinds of leaves, however distinct in theory, are of all leaves most liable to run into each other, even on the same plant, examples of which are frequent in the class *Tetradynamia.*

verticillato, *f.* 109, in a whorled manner, the leaflets cut into fine divaricated segments embracing the footstalk, as *Sium verticillatum*, *Fl. Brit. Engl. Bot. t.* 395.

Auriculatum, *f.* 110, an auricled leaf, is furnished at its base with a pair of leaflets, properly distinct, but occasionally liable to be joined with it, as *Salvia triloba*, *Fl. Græc. t.* 17, and *Dipsacus pilosus*, *Engl. Bot. t.* 877. Linnæus in the last example uses the term *appendiculatum*, which is correct, but superfluous, and I have therefore ventured to apply it somewhat differently, *p.* 133.

Conjugatum, *f.* 105, conjugate, or yoked, consists of only a pair of *pinnæ* or leaflets, and is much the same as *binatum*. Instances of it are afforded by the genus *Zygophyllum*, whose name, equivalent to Yoke-leaf, expresses this very character; also *Lathyrus sylvestris*, *Engl. Bot. t.* 805, and *latifolius*, *t.* 1108. *Bijugum*, *trijugum*, *quadrijugum*, *multijugum*, &c., express particluar numbers of pairs of leaflets, and are used for that purpose where such discrimination is requisite for specific characters, as in *Mimosæ*.

The different degrees in which leaves are compounded are thus distinguished, without any reference to the mode.

Compositum, *f.* 111, simply compound, as in the above instances.

Decompositum, *f.* 112*, doubly compound, as *Athamanta Libanotis*, *Engl. Bot. t.* 138, *Ægopodium Podagraria*, *t.* 940, and *Fumaria claviculata*, *t.* 103.

Supradecompositum, *f.* 113, thrice compound, or more, as *Caucalis Anthriscus*, *t.* 987, *C. daucoides*, *t.* 197, and *Bunium flexuosum*, *t.* 988. But

Bigeminatum, twice paired, as *Mimosa Unguis cati*, *Plum. Ic. t.* 4; and *tergeminatum*, thrice paired, as *M. tergemina*; also

Biternatum, *f.* 112, twice ternate, as *Ægopodium*, *Engl. Bot. t.* 940; *triternatum*, thrice ternate, as *Fumaria lutea*, *t.* 588; and

Bipinnatum, doubly pinnate, *tripinnatum*, triply pinnate, of which examples have just been given:

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* Linnæus, in *Phil. Bot.* 47, gives an erroneous definition of this term, which does not accord with his own use of it. Professor Martyn has rightly defined it.

all apply to the mode, as well as the degree, in which leaves are compounded.

Pedatum, *f.* 114, pedate, is a peculiar kind of leaf, being ternate, with its lateral leaflets compounded in their fore part, as *Helleborus fœtidus*, *Engl. Bot. t.* 613, and *H. niger*, *Curt. Mag. t.* 8. There is an affinity between a pedate leaf and those simple ones which are three-ribbed at the base, *p.* 128. See also the disposition of the lateral veins in *Aristolochia Clematitis*, *Engl. Bot. t.* 398.

In compounding the foregoing terms we must take care not to express a contradiction. Thus the leaves of many *Mimosæ*, as the *purpurea*, *Andr. Repos. t.* 372, and *sensitiva*, are *conjugata pinnata*, conjugate in the first instance, pinnate in the next, not *conjugato-pinnata*, of an intermediate nature between conjugate and pinnate, which is impossible. Neither are the leaves of *Mimosa pudica digitato-pinnata*, for there is no medium between the two terms; but they are digitate, or composed of leaflets proceeding from the top of a common foot-stalk, and those leaflets are pinnate. On the other hand *ovato-lanceolatum*, lanceolate approaching to ovate, or *elliptico-lanceolatum*, approaching to elliptic, as in the Privet, *Engl. Bot. t.* 764, whose leaves often assume that shape, are easily understood.

CHAPTER XVI.

OF THE FUNCTIONS OF LEAVES.

The knowledge of the functions of leaves, and their real use with regard to the plant, is a curious branch of vegetable physiology, which made but a slow progress long after the nature of many other parts had been deeply scrutinized and thoroughly explained.

Cæsalpinus (*De Plantis, p.* 6.) thought leaves merely a clothing, or a protection against cold and heat. He conceived that the rays of the sun, being moderated in passing through them, were prevented from acting too violently on the fruit and young buds. "Accordingly," says he, "many trees lose their leaves in autumn, when their fruits are perfected, and their buds hardened, while such as retain the fruit long, keep also their leaves; even till a new crop is produced, and longer, as in the Fir, the *Arbutus*, and the Bay. It is reported that in hot climates, where there is almost perpetually a burning sun, scarcely any trees lose their leaves, because they require them for shade." Cæsalpinus goes on to show that leaves proceed from the bark, with some remarks on the pith, (in which we may trace the origin of the Linnæan hypothesis of vegetation,) but which are now superseded by more accurate inquiries.

The above is certainly a very small part of the use of leaves. Yet the observations of this writer, the father of botanical philosophy among the moderns, are so far correct, that if the leaves of a tree be stripped off, the fruit comes to nothing, which is exemplified every year in Gooseberry bushes devoured by caterpillars; and though the fruit-trees of warm climates, partly naturalized with us, Grapes and Peaches for instance, ripen their fruit sooner perhaps if partially deprived of their leaves; yet if that practice be carried too far, the fruit perishes, as gardeners who tried it soon discovered. The White Mulberry indeed, cultivated in the south of Europe for the food of silkworms only, bears wonderfully the loss of its foliage three or four times a year. How far the fruit is injured nobody thinks it worth while to inquire, as it is never eaten, but it certainly does not fall off prematurely.

That Leaves imbibe and give out moisture has been long known, this being one of the most obvious facts belonging to them. Dr. Hales thought they might probably imbibe air; but since his time, more certain discoveries have been made concerning this point, as well as the effects of light upon leaves, which also did not escape the consideration of that great philosopher. All these subjects we shall mention in their turn.

That Leaves give out moisture, or are organs of insensible perspiration, is proved by the simple experiment of gathering the leafy branch of a tree, and immediately stopping the wound at its base with mastick, wax, or any other fit substance, to prevent the effusion of moisture in that direction. In a very short time the leaves droop, wither and are dried up. If the same branch, partly faded, though not dead, be placed in a very damp cellar, or immersed in water, the leaves revive, by which their power of absorption is also proved. Hence the use of a tin box to travelling botanists, for the purpose of restraining the evaporation of plants, and so preserving them fresh for some days till they can be examined, as well as of reviving faded plants, if the inside of the box be moistened before they are shut up in it.

Dr. Hales found that a plant of the Great Annual Sunflower, *Helianthus annuus*, lost 1 lb. 14 oz. weight in the course of twelve hours in a hot dry day. In a dry night it lost about 3 oz.; in a moist night scarcely any alteration was observable, but in a rainy night it gained 2 or 3 oz. The surface of the plant compared with that of its roots was, as nearly as could be calculated, in the proportion of five to two; therefore the roots must have imbibed moisture from the earth of the pot in which the plant grew, and which was all previously weighed, in the same proportion of five to two, otherwise the leaves would have faded. The same experiment was made on the Vine, the Cabbage, &c., with various results as to the exact degree of perspiration, but all proving it to be considerable. Evergreens are found to perspire much less than other shrubs.

The state of the atmosphere has a great effect on the rapidity of this perspiration. Practical botanists know how much sooner plants fade, and haymakers experience how much faster their work is done, some days than others, and those days are by no means always the most sunny. In a hot dry day plants are often exhausted, so as to droop very much towards evening, especially in the dry unsheltered bed of a garden. Such as have fleshy roots, indeed, have a singular power of resisting drought, which has already been explained *p.* 87. Succulent plants, destined to inhabit sunny rocks, or sandy deserts, imbibe with the greatest facility, and perspire very sparingly. Evergreens are not generally very succulent, but their cuticle appears to be constructed like that of succulent plants, so as to allow of little evaporation. The Cornelian Cherry, whose immense perspiration we have recorded, *p.* 52, has a thin dry leaf, capable of holding very little moisture.

The nature of the liquor perspired has been already noticed, *p.* 52. In hot weather it has been observed by Hales, Du Hamel and Guettard, to partake occasionally of the peculiar scent of the plant that yields it; but in general the odorous matter is of too oily a nature to be combined with it.

The sensible perspiration of plants is of various kinds. When watery, it can be considered only as a condensation of their insensible evaporation, perhaps from some sudden change in the atmosphere. Groves of Poplar or Willow exhibit this phænomenon, even in England, in hot calm weather, when drops of clear water trickle from their leaves like a slight shower of rain. Sometimes it is of a saccharine nature, as De la Hire observed in Orange trees; *Du Hamel Arb. v.* 1. 150. It is more glutinous in the *Tilia* or Lime-tree, more resinous in Poplars, as well as in *Cistus creticus*, from which last the resin called *Labdanum* is collected, by beating the shrub with leather thongs. See Tournefort's *Voyage*, 29. In the Fraxinella, *Dictamnus albus*, it is a highly inflammable vapour. Ovid has made an elegant use of the resinous exudation of Lombardy Poplars, *Populus dilatata*, *Ait. Hort. Kew. v.* 3. 406, which he supposes to be the tears of Phaëton's sisters, who were transformed into those trees. Such exudations must be considered as effusions of the peculiar secretions; for it has been observed that Manna may be scraped from the leaves of *Fraxinus Ornus*, *Fl. Græc. t.* 4, as well as procured by incision from its stem. They are often perhaps a sign of unhealthiness in the plant; at least such appears to be the nature of one kind of honey-dew, to which the Beech in particular is subject, and which, in consequence of an unfavourable wind, covers its leaves in the form of a sweet exudation, similar in flavour to the liquor obtained from its trunk. So likewise the Hop, according to Linnæus, *Faun. Suec.* 305, is affected with the honey-dew, and its flowers rendered abortive, in consequence of the attacks of the caterpillar of the Ghost Moth, *Phalæna Humuli*, upon its roots. In such case the saccharine exudation must decidedly be of a morbid nature*. That wax is also an exudation from the leaves of plants, appears from the experiments recorded by Dr. Thomson in his *Chemistry*, *v.* 4. 298, and it has been long ago asserted that wax may easily be gathered from the leaves of Rosemary. On this subject I have not made any experiments to satisfy myself.

With respect to the absorbing power of leaves, the best observations that have been made are those of Bonnet, recorded in the beginning of his *Recherches sur l'Usage des Feuilles.* His aim was, by laying leaves of various plants upon the top of a jar of water, some with their upper, and others of the same species with their under, surfaces applied to the water, to discover in which situation the leaves of each plant continued longest in health and vigour, and also how far different species differed from each other in this respect. The results were in many instances highly curious.

Of fourteen herbaceous plants tried by this philosopher, six lived nearly as long with one surface applied to the water as with the other; these were the common *Arum maculatum*, the French Bean, the Sunflower, Cabbage, Spinach and the Small Mallow. By the last I presume is meant *Malva rotundifolia*, *Engl. Bot. t.* 1092. Six others, Plantain, White Mullein,

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[*] I do not mean to dispute the accuracy of Mr. Curtis's excellent paper, *Tr. of Linn. Soc. v. 6,* written to prove honey-dew to be the dung of *Aphides.* I only contend that there are more than one kind of honey-dew.

the Great Mallow (probably *M. sylvestris*, *t.* 671), the Nettle, Cock's-comb, and Purple-leaved Amaranth (probably *Amaranthus hypochondriacus*), lived longest with their upper surface laid upon the water. The Nettle lived but three weeks with its under surface on the water, and about two months in a contrary position. The Mullein scarcely survived five or six days, and the Amaranth not a week, in the first-mentioned posture, while the leaves of the former remained in vigour about five weeks, and of the latter three months, when their upper surfaces imbibed the water. Marvel of Peru and Balm, the two remaining plants of the fourteen on which the experiment was made, had also an evident advantage in receiving that fluid by their upper surfaces. The leaves of some of the above species were found to thrive better when their stalks only were immersed in water, than when either of their sides was supplied with it, and the reverse was observable in several others; but the White Mullein, the Plantain and the Amaranth survived longer when they received the water by their stalk than by their under surface, though not so long as when it was applied to their upper sides.

Of sixteen trees tried by Bonnet, the Lilac and the Aspen, *Populus tremula*, were the only leaves that seemed to imbibe water equally well by either surface, whilst all the others evidently succeeded best with their under sides laid upon the water, being in that respect the reverse of herbaceous plants. Of these the White Mulberry leaf was the most remarkable, not living more than five days when supplied by the upper surface, while such as floated on their backs continued in perfection near six months. The Vine, the Poplar, (probably *Populus nigra*), and the Walnut, were no less remarkable, for fading almost as soon, when fed by their upper surface, as when left without any water at all. Many of the other trees imbibed water as well, or better, by their foot-stalks as by their upper surfaces. Hazel-nut and Rose leaves, when laid with their backs upon the water, imbibe sufficiently to nourish other leaves on the same branch; so will one leaflet of a French bean supply its neighbour that does not touch the water.

Those who wish to repeat these experiments should be careful to choose full-grown healthy leaves, all as nearly as possible of the same age and vigour. It is also desirable that the precise species of plant should be recorded by its scientific name. For want of this, Bonnet, who despised method and nomenclature, has left us in uncertainty concerning several of the plants he examined. We ought to have been accurately informed what species of Poplar differed so remarkably in its power of absorption from the Aspen, another of the same genus. We ought likewise to have been told what Sun-flower, what Nettle, Amaranth and Mallows were examined; for want of which information the authority of such experiments is much impaired.

From the foregoing observations we learn the importance of shading and watering plants newly removed, cuttings, grafts, &c. and on the other hand the benefit of heat and air to promote due perspiration and evaporation.

The perspiration of aquatic plants seems to be remarkably copious. Of these some grow constantly immersed in the water, as most species of *Potamogeton*, Pond-weed, *Engl. Bot. t.* 168, 297, 376, &c. Their leaves are peculiarly vascular, and dry very quickly in the air, withering in a very few minutes after exposure to it. Their absorbing power seems equally great, so that they appear to be continually, in their natural situation, imbibing and giving out a quantity of water much greater than has been observed in land plants. Other aquatics, as the *Nymphæa*, *Engl. Bot. t.* 160, float with only the upper surface of their leaves exposed to the air, which surface is so contrived that water will scarcely remain upon it. These leaves, though extremely juicy, dry with great rapidity, as does every part of the plant when gathered. It is probable that they imbibe copiously by their under sides, and perspire by the upper.

The œconomy of the *Sarracenia*, an American genus of which we now know four species, and of the East Indian *Nepenthes distillatoria*, deserves particular mention. Both grow in bogs, though not absolutely in the water. The former genus has tubular leaves which catch the rain like a funnel and retain it; at least such is the nature of *S. purpurea*, *Curt. Mag. t.* 849, whose margin seems dilated expressly for this purpose, while the orifice of the tubular part just below is contracted to restrain evaporation. Linnæus conceived this plant to be allied in constitution to *Nymphæa*, and consequently to require a more than ordinary supply of water, which its leaves were calculated to catch and to retain, so as to enable it to live without being immersed in a river or pond. But the consideration of some other species renders this hypothesis very doubtful. *S. flava*, *t.* 780, and more especially *S. adunca*, *Exot. Bot. t.* 53, are so constructed that rain is nearly excluded from the hollow of their leaves, and yet that part contains water, which seems to be secreted by the base of each leaf. What then is the purpose of this unusual contrivance? An observation communicated to me in 1805, in the botanic garden at Liverpool, seems to unravel the mystery. An insect of the *Sphex* or *Ichneumon* kind, as far as I could learn from description, was seen by one of the gardeners to drag several large flies to the *Sarracenia adunca*, and, with some difficulty forcing them under the lid or cover of its leaf, to deposit them in the tubular part, which was half filled with water. All the leaves, on being examined, were found crammed with dead or drowning flies. The *S. purpurea* is usually observed to be stored with putrefying insects, whose scent is perceptible as we pass the plant in a garden; for the margin of its leaves is beset with inverted hairs, which, like the wires of a mouse-trap, render it very difficult for any unfortunate fly, that has fallen into the watery tube, to crawl out again. Probably the air evolved by these dead flies may be beneficial to vegetation, and, as far as the plant is concerned, its curious construction may be designed to entrap them, while the water is provided to tempt as well as to retain them. The *Sphex* or *Ichneumon*, an insect of prey, stores them up unquestionably for the food of itself or its progeny, probably depositing its eggs in their carcases, as others of the same tribe lay their eggs in various caterpillars, which they sometimes bury afterwards in the ground. Thus a double purpose is answered; nor is it the least curious circumstance of the whole, that an Europæan insect should find out an American plant in a hot-house, in order to fulfil that purpose.

If the above explanation of the *Sarracenia* be admitted, that of the *Nepenthes* will not be difficult. Each leaf of this plant terminates in a sort of close-shut tube, like a tankard, holding an ounce or two of water, certainly secreted through the footstalk of the leaf, whose spiral-coated vessels are uncommonly large and numerous. The lid of this tube either opens spontaneously, or is easily lifted up by insects and small worms, who are supposed to resort to these leaves in search of a purer beverage than the surrounding swamps afford. Rumphius, who has described and figured the plant, says "various little worms and insects crawl into the orifice, and die in the tube, except a certain small *Squilla* or shrimp, with a protuberant back, sometimes met with, which lives there."—I have no doubt that this shrimp feeds on the other insects and worms, and that the same purposes are answered in this instance as in the *Sarraceniæ*. Probably the leaves of *Dionæa muscipula*, as well as of the *Droseræ*, *Engl. Bot. t.* 867—869, catch insects for a similar reason.

I proceed to consider the effects of Air and Light upon vegetables.

Dr. Grew, by the assistance of the microscope, detected a quantity of vesicles full of air in the leaves of plants, as also the spiral-coated vessels of their stems, which last he and all other physiologists, till very lately, considered as air-vessels likewise. Malpighi made the same observations about the same time; and as these two acute and laborious philosophers pursued their inquiries without any mutual communication, their discoveries strengthen and confirm each other. Their books have long served as magazines of facts for less original writers to work with. From their remarks physiologists have *theoretically* supposed that leaves imbibed air, which the spiral vessels were believed to convey all through the plant, in order that it might act on the sap as it does on the animal blood. The analogy thus understood was not correct, because air is conveyed no further than the lungs of animals; but without this hypothesis no use could be found for the supposed longitudinal air-vessels.

The observations of Dr. Hales come next in order to those of Grew and Malpighi. By means of the air-pump, an instrument much in use in his time, Hales obtained abundance of air from every part of the vegetable body, as well as from recently extracted sap. Plants were found to perish very soon in an exhausted receiver. Some of this great man's experiments, however, require to be received with caution. He rightly remarked that air was not only taken in by plants very copiously along with their food, but also imbibed by their bark; see *Veg. Staticks*, *chap. 5*. But when, from observing that it would freely from the bark pervade the longitudinal vessels of a branch, he concluded that Malpighi and Grew were right in their ideas of longitudinal air-vessels, he was misled by appearances. We cannot but be aware that, when a branch is gathered, the sap must soon flow out of those spiral coated tubes, which are large, elastic, and, no doubt, irritable. After they are emptied, air may unquestionably pass through them, especially when the whole weight of the atmosphere is acting, as in Dr. Hales's experiments with the air pump, upon so delicate a fabric as the internal vascular structure of a plant, forcing its way through pores or membranes not naturally designed to admit it. We must also recollect that a plant, cut even for a short time, begins to lose its vital principle, after which no just judgement can be formed, by any experiments, concerning the movements of its fluids in life and vigour. See *Chapter* 1, These experiments of Dr. Hales therefore prove no more than that the vegetable body is pervious in various directions; and perhaps the only point they correctly establish is, that air is imbibed through the bark, a part known to be full of air-vessels. But the seventh chapter of the *Vegetable Staticks* contains some remarks much more to our purpose. Dr. Hales there clearly anticipates by conjecture, what succeeding philosophers, more enlightened chemists, have ascertained. His words are remarkable:

"We may therefore reasonably conclude, that one great use of leaves is what has been long suspected by many, *viz.* to perform in some measure the same office for the support of the vegetable life, that the lungs of animals do, for the support of the animal life; plants very probably drawing through their leaves some part of their nourishment from the air." *p.* 326. A little further on he adds, "And may not light also, by freely entering the expanded surfaces of leaves and flowers, contribute much to the ennobling the principles of vegetables?" *p.* 328.

Next in order of time to those of Hales follow the experiments of Bonnet. We have already detailed his observations on the power of leaves to imbibe moisture; whence it is ascertained that plants are furnished with a system of cuticular absorbents, which carry fluids into their sap-vessels, so as to enable them in some degree to dispense with supplies from the root. With respect to the effects of air upon leaves, this ingenious philosopher has not been equally successful. He is recorded as the discoverer of the expiration of plants; but it appears from his work that he merely observed the bubbles of air which cling to leaves, dead as well as living, and indeed to any other body, when immersed in water and exposed to the light of the sun. He found these bubbles disappeared in the evening, and returned again when the sun shone, and he faithfully reports that by their attachment to the surfaces of leaves, the latter were rendered more buoyant, and rose in the water; a sure proof that the air had not previously existed, in the same volume at least, in the substance of those leaves. Accordingly, Bonnet concluded that the latter, in imbibing the surrounding water, left the air which had been contained in the water, and that this liberated air became visible from being warmed and rarefied by the sun. This was as near the truth as Bonnet could come, it not being then known that light has a power of separating air of a peculiar kind, carbonic acid gas, from water. I find no indications in his work of his having had any idea of leaves absorbing air and giving it out again; still less of their effecting any change in it properties.

Dr. Priestley was the first who suggested this last-mentioned quality in vegetables. He ascertained their power of absorbing carbonic acid gas, denominated by him fixed air, and giving out oxygen gas, or pure respirable air. It was also his opinion that leaves imbibed the former by their upper, and gave out the latter by their under surface. He found some aquatic or marsh plants extremely powerful in this respect, especially the Willow-herb or *Epilobium*, and the *Conferva*, a minute branching cotton-like vegetable which grows in putrid water, and the production of which, in water become foul, from long keeping on ship-board, Dr. Priestley judged to operate principally in restoring that fluid to a state fit for use.

Dr. Ingenhousz, pursuing Dr. Priestley's inquiries, found light to be necessary to these functions, and that in the dark leaves gave out a bad air. He observed moreover that fruits and flowers almost invariably gave out a bad, or carbonic, air, but more especially in the dark. He probably carries his ideas, of the deleterious effects of this air on animal life, too far; for no mischief has ever happened, as far as common experience goes, to persons sleeping in apple or olive chambers, neither do the inhabitants of the confined huts in Covent-garden market apparently suffer, from living day and night among heaps of drying herbs. Mischiefs have unquestionably arisen from flowers in a bed-room, or any other confined apartment, but that is to be attributed to their perfumed effluvia. So the bad effects, observed by Jacquin, of *Lobelia longiflora* on the air of a hot-house, the danger incurred by those who sleep under the Manchineel-tree, *Hippomane Mancinella*, or, as it is commonly believed, under a Walnut-tree, are probably to be attributed as much to poisonous secretions as to the air those plants evolve.

Dr. Ingenhousz introduced leaves into glass jars filled with water, which he inverted in a tub of the same water, and placed the whole together in the sunshine. From their under sides came streams or bubbles of air, which collected in the inverted bottom of each jar. The air thus procured proved oxygen gas, more or less pure. The *Nymphæa alba*, *Engl. Bot. t.* 160, affords an extraordinary abundance of it. Dr. Ingenhousz observed plants to be very various in their mode of emitting these bubbles, but it was always uniform in the same species. Air collected from water placed in similar circumstances without plants, proved not oxygen, but much worse than common air, *viz.* carbonic acid gas, which following chemists have confirmed, and which we have already mentioned. Ingenhousz also found the air collected from plants under water in the dark worse than common air, especially that from walnut-leaves; which confirms the common opinion, above alluded to, respecting this tree.

Plants purify air very quickly. A vine-leaf in an ounce phial of carbonic acid gas, that immediately extinguished a candle, placed in the sun, without water, changed it to pure respirable air in an hour and half. Dr. Priestley found plants to alter even unmixed inflammable air, or *hydrogen*, especially the *Epilobium hirsutum*, if I mistake not, and *Polygonum Hydropiper*.

Succulent plants are found to afford most air, in consequence of the abundance of their Cellular Integument, or *Parenchyma*, in which, as I have hinted in the fourth chapter, the chemical operations of the leaves are performed, That Light has a very powerful effect upon plants has long been known, independent of the remarks of Hales or Ingenhousz. The green colour of the leaves is owing to it, insomuch that plants raised in darkness are of a sickly white. It has even been observed that when light is admitted to the leaves through different glasses, each tinged of a different prismatic colour, the plant is paler in proportion as the glass approaches nearer to violet. The common practice of blanching Celery in gardens, by covering it up from the light, is an experiment under the eyes of every one. This blanching of plants is called by the French étiolation, and our chemists have adopted the term, though I think they err in deriving it from *étoile*, a star. When blanched plants are brought into the light, they soon acquire their natural green colour, and even in the dark they are green, if exposed to the action of hydrogen gas. Tulip and Crocus flowers have long ago been observed by Sennebier to be coloured even in the dark, apparently because their colour depends on a different principle from the green of leaves.

Light acts beneficially upon the upper surface of leaves, and hurtfully upon the under side; hence the former is always turned towards the light, in whatever situation the plant may happen to be placed. Trees nailed against a north wall turn their leaves from the wall, though it be towards the north, and in direct opposition to those on a southern wall over against them. Plants in a hot-house all present the fronts of their leaves, and this influences even the posture of the branches, to the side where there is most light, but neither to the quarter where most air is admitted, nor to the flue in search of heat. If the branches of a trained fruit-tree in full leaf be disturbed in their position, the leaves resume their original direction in the course of a day or two. The brighter the day, the more quickly is this accomplished. If the experiment be often repeated, they continue to turn, but more weakly, and are much injured by the exertion. Black spots appear about the veins on their under sides, and the cuticle scales off. Succulent leaves, though so thick and firm as many of them are, have been observed to be peculiarly sensible to light, while other plants, as Mallows, according to Bonnet, are much less so. The Miseltoe, *Viscum album*, *Engl. Bot. t.* 1470, the two sides of whose leaves are alike in appearance, and both equally, in general, presented to the light, are not found to turn upon any change in the posture of the branch. Neither do upright sword-shaped leaves alter their position, because in them both sides must be presumed to perform the same functions with respect to light as well as air.

Mr. Calandrini found vine-leaves turned to the light when separated from the stem and suspended by a thread. Of this any one may be easily satisfied, provided the experiment be made with sufficient care and delicacy. It is important, as demonstrating the turning to be accomplished by an impression made on the leaf itself, and not upon its footstalk.

Nor is this effect of light peculiar to leaves alone. Many flowers are equally sensible to it, especially the compound radiated ones, as the Daisy, Sun-flower, Marigold, &c. In their forms Nature seems to have delighted to imitate the radiant luminary to which they are apparently dedicated, and in the absence of whose beams many of them do not expand their blossoms at all. The stately Annual Sun-flower, *Helianthus annuus*, displays this phænomenon more conspicuously on account of its size, but many of the tribe have greater sensibility to light. Its stem is compressed in some degree, to facilitate the movement of the flower, which, after following the sun all day, returns after sun-set to the east, by its natural elasticity, to meet his beams in the morning. Dr. Hales thought the heat of the sun, by contracting the stem on one side, occasioned the flower to incline that way; but if so, it would scarcely return completely at night. There can be no doubt, from the observation of other similar flowers, that the impression is made on their radiated florets, which act as wings, and seem contrived chiefly for that purpose, being frequently destitute of any other use. A great number of leaves likewise follow the sun in its course; a clover-field is a familiar instance of this.

Of all leaves those of pinnated leguminous plants are found most affected by light, insomuch that it appears, in several cases, the sole cause of their expansion, for when it is withdrawn they fold over each other, or droop, as if dying; and this is called by Linnæus the Sleep of Plants, who has a dissertation on the subject in his *Amœnitates Academicæ*. The term Sleep may not really be so hyperbolical as at first sight it seems; for the cessation of the stimulus of light, and of the consequent restrained position of the leaves, may be useful to the vegetable constitution, as real sleep is to the animal. Another purpose is answered by the nocturnal folding of some leaves, that they shelter their flowers from the dew, the advantage of which we shall explain hereafter.

Some pinnated leaves display a more extraordinary sensibility, not merely to light, but to the touch of any extraneous body, or to any sudden concussion, as those of *Mimosa sensitiva*, and *pudica*, *Oxalis sensitiva*, and *Smithia sensitiva*, *Ait. Hort. Kew. v.* 3. *t.* 13. An impression made even in the most gentle manner, upon one of their leaflets, is communicated in succession to all of them, evincing an exquisite irritability, for it is in vain to attempt any mechanical solution of this phænomenon. One of this tribe, *Hedysarum gyrans*, has a spontaneous motion in its leaves, independent of any external stimulus, even of light, and only requiring a very warm still atmosphere to be performed in perfection. Each leaf is ternate, and the small lateral leaflets are frequently moving up and down, either equably or by jerks, without any uniformity or cooperation among themselves. It is difficult to guess at the purpose which this singular action is designed to answer to the plant itself; its effect on a rational beholder cannot be indifferent.

The chemical actions of light, heat, and the component parts of the atmospheric air, upon leaves, and, where the latter are wanting, on the green stems of plants, are now, as far as concerns all plants in common, tolerably well understood. The observations and experiments of Priestley and Ingenhousz have been confirmed, extended in a variety of ways, or explained on the principles of improved chemistry, by Dr. Percival and Mr. Henry in England, Dr. Woodhouse in America, and M. Sennebier and M. Théodore de Saussure, as well as various other philosophers, on the continent of Europe. It is agreed that in the day-time plants imbibe from the atmosphere carbonic acid gas, (which was formerly called fixed air, and is an union of oxygen and carbon), that they decompose it, absorb the carbon as matter of nourishment which is added to the sap, and emit the oxygen. So they absorb the same gas from water, when it is separated from that fluid by the action of light. The burning of a candle, or the breathing of animals, in confined air, produces so much of this gas, that neither of these operations can go on beyond a certain time; but the air so contaminated serves as food for vegetables, whose leaves, assisted by light, soon restore the oxygen, or, in other words, purify the air again. This beautiful discovery, for the main principles of which we are indebted to the celebrated Dr. Priestley, shows a mutual dependance of the animal and vegetable kingdoms on each other, which had never been suspected before his time. Comparative experiments upon the lower tribes of these kingdoms have not yet been made, but they would probably afford us a new test for distinguishing them. The air so copiously purified by a *Conferva*, one of the most inferior in the scale of plants, may be very extensively useful to the innumerable tribes of animated beings which inhabit the same waters. The abundant air-bubbles which have long ago given even a botanical name to one supposed species, *Conferva bullosa*, are probably a source of life and health to whole nations of aquatic insects, worms and polypes, whenever the sun shines.

In the dark, plants give out carbon and absorb oxygen: but the proportion of the latter is small, compared to what they exhale by day, as must likewise be the proportion of carbon given out; else the quantity of the latter added to their substance would be but trifling, especially in those climates where the proportion of day to night is nearly equal, and which, notwithstanding, we know to be excessively luxuriant in vegetation. Plants also give out azotic gas: but M. de Saussure is of opinion that this proceeds from their internal substance; and it appears by his experiments to be rather a sign of disease or approaching decay, than a regular chemical production of their constitution when in health; for Sennebier found the quantity of oxygen emitted was in proportion to the thickness of the leaf, or quantity of parenchyma. Yet the parenchyma must be in its original organized state, for when bruised its functions are destroyed.

Possibly such an alternation in the functions of vegetables between day and night may afford a necessary repose to their vital principle, whose share in them we know to be of primary importance. Whatever may happen to plants in the dark, there can be no doubt of their principal business in the œconomy of nature being what we have described. The most luminous and compendious view of the whole subject is given by Dr. Thomson of Edinburgh in the fourth *vol.* of his *Chemistry*, which is well worth the attention of those who wish to enter more deeply into all the various chemical examinations respecting it than suits our purpose. It is only necessary to add a short view of Dr. Darwin's hypothesis which Dr. Thomson has not mentioned, probably on account of its insufficiency. That lively writer thought the watery perspiration of leaves, acted upon by light, gave out oxygen for the use of the plant itself, such oxygen being immediately absorbed by the air-vessels. This is by no means adequate to explain any of the phænomena, but rather contradictory to most of them, and is totally superseded by the observations and experiments of other writers.

There can be no question of the general purpose answered to the vegetable constitution by these functions of leaves. They confirm Mr. Knight's theory of vegetation, who has proved that very little alburnum or new wood is secreted when light is kept from the leaves. They also help us to understand how essential oils may be produced, which are known, as well as sugar, to be composed of oxygen, hydrogen and carbon in different proportions. We can now have a general idea how the nutritious sap, acted upon by all the agents above mentioned during its stay in the cellular substance of the leaf, and returned from thence impregnated with them into the bark, may prove the source of increase, and of peculiar secretions, in the vegetable frame. That portion of sap sent to the flower and fruit undergoes no less remarkable changes, for purposes to which those curious organs are devoted; nor is it returned from thence, as from the leaves, to answer any further end. The existence of those organs is still more temporary, and more absolutely limited to their own purposes, than even that of the leaves, from whose secretions theirs are very distinct.

But when we attempt to consider how the particular secretions of different species and tribes of plants are formed; how the same soil, the same atmosphere, should in a leaf of the vine or sorrel produce a wholesome acid, and in that of a spurge or manchineel a most virulent poison; how sweet and nutritious herbage should grow among the acrid crowfoot and aconite, we find ourselves totally unable to comprehend the existence of such wonderful powers in so small and seemingly simple an organ as the leaf of a plant. The agency of the vital principle alone can account for these wonders, though it cannot, to our understanding, explain them. "The thickest veil," says Dr. Thomson at the end of his chapter on vegetation, "covers the whole of these processes; and so far have philosophers hitherto been from removing this veil, that they have not even been able to approach it. All these operations, indeed, are evidently chemical decompositions and combinations; but we neither know what these decompositions and combinations are, nor the instruments in which they take place, nor the agents by which they are regulated."

The vain Buffon caused his own statue to be inscribed "a genius equal to the majesty of nature," but a blade of grass was sufficient to confound his pretensions.

CHAPTER XVII.

OF THE SEVERAL KINDS OF FULCRA, OR APPENDAGES TO A PLANT.

THE word *Fulcrum*, whose proper meaning is a prop or support, has been applied by Linnæus not only to those organs of vegetables correctly so denominated, such as tendrils, but also to various other appendages to the herbage of a plant, none of which are universal, or essential, nor is there any one plant furnished with them all. I prefer the English term *Appendages* for these organs in general, to *Props*, because the latter applies only to one of them. Seven kinds of these are distinguished by Linnæus, nor do I find it necessary to enlarge that number.

1. *Stipula*. The Stipula, a leafy appendage to the proper leaves or to their footstalks. It is commonly situated at the base of the latter, in pairs, and is extremely different in shape in different plants.

   The most natural and usual situation of the Stipulas is in pairs, one stipula on each side of the base of the footstalk, as in *Lathyrus latifolius*, *Engl. Bot. t.* 1108, whose stipulas are half arrow-shaped, *f.* 115; also in Willows, as *Salix stipularis*, *t.* 1214, and *S. aurita*, *t.* 1487. In *Rosa*, *Potentilla*, and many genera allied to them, the stipulas are united laterally to the footstalk, *f.* 116. See *Potentilla alba*, *t.* 1384. In all these cases they are *extrafoliaceæ*, external with respect to the leaf or footstalk; in others they are *intrafoliaceæ*, internal, and are then generally simple, as those of *Polygonum*, *t.* 1382, 756, &c. In a large natural order, called *Rubiaceæ*, these internal stipulas in some cases embrace the stem in an undivided tube above the insertion of the footstalks, like those of *Polygonum* just mentioned; in others, as the Coffee, *Coffea arabica*, and the *Hamellià patens*, *Exot. Bot. t.* 24, they are separate leaves between the footstalks, but meeting just above their insertion. The Europæan *Rubiaceæ* have whorled leaves, as *Asperula*, *Galium*, *Rubia*, &c.; but *Asperula cynanchica*, *Engl. Bot. t.* 33, has sometimes two of its four leaves so small as to look like stipulas, seeming to form an intermediate link between such as have whorled leaves and such as have opposite ones with stipulas. The next step from *Asperula* is *Diodia*, and then *Spermacoce*. In the two last the bases of the stipulas and footstalks are united into a common tube.

Some stipulas fall off almost as soon as the leaves are expanded, which is the case with the Tulip-tree, *Liriódendron tulipifera*; in general they last as long as the leaves.

The absence or presence of these organs, though generally an indication that plants belong to the same natural order and even genus, is not invariably so. Some species of *Cistus* have stipulas, others none, which is nearly the case with grasses. The stipula in this, one of the most distinct of all natural orders, is peculiar, consisting of an internal white membrane crowning the sheath of their leaf, and clasping the culm. See *Phalaris canariensis*, *Engl. Bot. t.* 1310, and *Lagurus ovatus*, *t.* 1334. In *Aria cærulea*, *t.* 750, a few minute hairs supply its place, while *Sesleria cærulea*, *t.* 1613, and some maritime grasses, have scarcely more than the rudiment of a stipula. Old writers call this organ in grasses by a peculiar name *ligula*, and others denominate it *membrana foliorum*, but both terms are superfluous. A curious instance of stipulas supplying the place of leaves is observable in *Lathyrus Aphaca*, *t.* 1167, which has only one or two pair of real leaves on the seedling plants, and those soon disappear, serving chiefly to prove, if any proof were wanted, that the rest are true stipulas.

Remarkably scariose, or dry membranous stipulas are seen in *Illecebrum Paronychia*, *Fl. Græc. t.* 246, and in the genus *Pinus*.

2. *Bractea*. The floral leaf, a leafy appendage to the flower or its stalk. It is of a variety of forms, and sometimes green, sometimes coloured. The Lime-trees, *Tilia europæa*, *f.* 117, *Engl. Bot. t.* 610, and *parvifolia*, *t.* 1705, have a very peculiar oblong

pale floral leaf, attached to the flower-stalk. The Lavenders, *f.* 118, see *Curt. Mag. t.* 400 and 401, have coloured bracteas, and the Purple-topped Clary, *Salvia Horminum*, *Fl. Græc. t.* 20, exhibits a gradation from the proper leaves to green bracteas, and from them to coloured ones, which last are barren, or unaccompanied by flowers. Hence I am induced to believe this plant a mere variety of *S. viridis*, *t.* 19, all whose bracteas are green and fertile. *Bartsia alpina*, *Engl. Bot. t.* 361, and *Melampyrum arvense*, *t.* 53, display an elegant transition from leaves to coloured bracteas. The Orchis tribe have green leafy bracteas, different in size in different species. A most beautiful large and coloured bractea is produced in *Mussænda frondosa*, *Hort. Mal. v.* 2. *t.* 18, from one of the teeth of the calyx, also in *M. glabra* of Willdenow, and two new species brought from America by Mr. John Fraser. Spinous bracteas of a curious construction guard the calyx in *Atractylis cancellata*, *f.* 119. Linnæus observes that no bracteas are to be found in the class *Tetradynamia*.

The *ocrea* of Rottboll, *Willdenow's Principles of Botany*, 50, which enfolds the flower-stalks in *Cyperus*, see *Engl. Bot. t.* 1309, seems to me a species of bractea.

3. *Spina*, *f.* 120. A Thorn. This proceeds from the wood itself, and is either terminal like *Hippophae*

rhamnoides, *Engl. Bot. t.* 425, *Rhamnus catharticus*, *t.* 1629; or lateral as *Cratægus* (or *Mespilus*) *Crus-galli*, *tomentosa*, *parvifolia*, &c.

Linnæus observes that this sometimes disappears by culture, as in the Pear-tree, *Pyrus sativa*, which when wild has strong thorns; hence he denominates such cultivated plants *tamed*, or deprived of their natural ferocity. Professor Willdenow, *Principles of Bot. t.* 270, considers thorns as abortive buds, and thence very ingeniously and satisfactorily accounts for their disappearance whenever the tree receives more nourishment.

The permanent footstalks of the Gum Tragacanth shrub, *Astragalus Tragacantha*, are hardened into real spines, as are the flower-stalks in *Pisonia*, as well as the stipulas of *Xanthium spinosum* and the *Mimosæ*.—*Linn. Mss.*

4. *Aculeus*, *f.* 121, a Prickle, arises from the bark only, and comes off with it, having no connection with the wood, as in *Rosa*, *Rubus* (the Bramble Raspberry, &c.), and *Zizyphus*, *Willd. Sp. Pl. v.* 1. 1102.

This is not liable to disappear by culture, being very distinct in nature from the last.

5. *Cirrus*, *t.* 9. *f.* 122. A Tendril. This is indeed properly called a *fulcrum* or support, being intended solely to sustain weak and climbing stems upon more

firm and sturdy ones. By its means such climbers often reach, in tropical forests, to the summits of lofty trees, which they crown with adventitious blossoms. Tendrils or claspers when young are usually put forth in a straight direction ; but they presently become spiral, making several circumvolutions, by which they take hold of any thing in their way, and then assume a firmer texture. After accomplishing a certain number of turns in one direction, some tendrils have a power of twining subsequently the contrary way; many of them moreover are branched or compound, so that the chances of their meeting with a support are multiplied. The Vine, *Vitis vinifera*, the various species of Passion-flower, and the Pea or Vetch tribe afford good examples of spiral tendrils. The Virginian Creeper *Hedera*, or, as it ought to be called, *Vitis*, *quinquefolia*, has branched tendrils, whose extremities adhere to the smoothest flint, like the fibres of Ivy. *Gloriosa superba*, *f.* 76, *Andr. Repos. t.* 129, and *Flagellaria indica*, have a simple spiral tendril at the end of each leaf; for they belong to the *Monocotyledones*, the structure of whose whole herbage is generally of the most simple and compendious kind. The flower-stalks of *Cardiospermum Halicacabum* bear tendrils; but a most singular kind of tendril, if it may so be called, which certainly has a right to the name of *fulcrum*, is found in the *Annona hexapetala*, *Linn. Suppl.* 270. The flower-stalk of this tree forms a hook, and grasps the neighbouring branch, serving to suspend the fruit, which is very heavy, resembling a bunch of grapes, and indicates the plant in question to be either a *Michelia* or an *Uvaria*.

6. *Glandula*, a Gland, is defined by Linnæus as a little tumour discharging a fluid. Such are abundant on the stalk and calyx of a Moss Rose, *f.* 123, *Curt. Mag. t.* 69, and between the serratures of the leaf of *Salix pentandra*, Bay-leaved Willow; also on the footstalks of *Viburnum Opulus*, *Engl. Bot. t.* 332, and various species of Passion-flower. The liquor discharged is in the first-mentioned instances resinous and fragrant, in the latter a sort of honey.

7. *Pilus*, *f.* 124. A Hair. This, according to the Linnæan definition, is an excretory duct of a bristle-like form. Such it undoubtedly is in the Nettle, *Urtica*, *Engl. Bot. t.* 148, and *t.* 1236, whose bristles are tubular and pervious, having each a bag of poison at its base, like the fang of a serpent; as well as in numerous plants whose hairy coats exude a viscid moisture. But the hairs which clothe many plants are merely a protection against cold, heat, or insects. Sometimes they are hooked, sometimes branched and entangled, as in Mullein, *Verbascum*, *t.* 549, &c. In *Croton*, *Solanum*, and *Lavatera*,

they have often a starry figure. Very generally they are found, under a microscope, to be curiously jointed. Some *Begoniæ* bear on their leaves flat little straps called by authors *ramenta*, shavings, instead of cylindrical hairs; but I know not that they at all differ in nature from the usual pubescence, nor do they merit to be particularly distinguished. Some of the natural order of *asperifoliæ*, as *Echium*, *t.* 181, and *Lycopsis*, *t.* 938, especially some exotic species of this order, are clothed with curious white hard tubercles from which their bristles proceed. *Echium pyrenaicum*, *Desfont. Atlant. v.* 1. 164, is an instance of this, *f.* 125.

The pubescence of plants varies greatly in degree according to differences of soil or exposure; several kinds, as *Mentha hirsuta*, *t.* 447, 448, naturally hairy, being occasionally found smooth, but if transplanted they soon resume their proper habit. Yet the direction of the hairs or bristles proves a very sure means of distinguishing species, especially in the genus *Mentha*, the hairs about whose calyx and flower-stalk point differently in different species, and I have found it the only infallible distinction between one Mint and another. See *Trans. of Linn. Soc. v.* 5. 171. The accurate Dr. Roth has lately applied the same test to the species of *Myosotis*, which all botanists before him had either confounded under *M. scorpioides*, *Engl. Bot. t.* 480, or else separated upon vague principles. Some species of *Galium* are admirably characterized by the bristles of their leaves, or of parts of their leaves, being hooked backward or forward. We therefore accept the 272d maxim of Linnæus's *Philosophia Botanica* with that limitation which he himself has allowed in his commentary upon it. "The Pubescence," says he, "is a ridiculous distinction, being for the most part effaced by culture." After quoting examples, he concludes: "We are therefore not to have recourse to the hairiness or spines of plants but in case of absolute necessity." Such necessity every botanist will allow to have existed in the *Menthæ* and in *Myosotis scorpioides*; and though the *degree* of pubescence varies from culture, and even its *structure* be changeable, as in *Hedypnois hispida*, *Engl. Bot. t. 554*, and *hirta*, *t. 555*, its *direction* is I believe as little liable to exception as any character that vegetables present.

CHAPTER XVIII.

OF THE INFLORESCENCE, OR MODE OF FLOWERING, AND ITS VARIOUS FORMS.

INFLORESCENCE, *inflorescentia*, is used by Linnæus to express the particular manner in which flowers are situated upon a plant, denominated by preceding writers the *modus florendi*, or manner of flowering. Of this the several kinds are distinguished as follows.

VERTICILLUS, *f.* 126. A Whorl. In this the flowers surround the stem in a sort of ring; though they may not perhaps be inserted on all sides of it, but merely on two opposite ones, as in Dead Nettle, *Lamium*, *Engl. Bot. t.* 768—770, *Mentha rubra*, *t.* 1413, and *Clinopodium vulgare*, *t.* 1401; or even on one side only, as *Rumex maritimus*, *t.* 725. The flowers of *Hippuris vulgaris*, *t.* 763, are truly inserted in a ring round the stem, *f.* 127; but they are not whorled independent of the leaves, and are therefore more properly, with a reference to the leaves, denominated axillary and solitary.

RACEMUS, *f.* 128, a Cluster, or Raceme, consists of numerous rather distant flowers, each on its own proper stalk, and all connected by one common stalk, as a bunch of Currants, *Ribes rubrum*, *Engl.*

Bot. t. 1289, *nigrum*, *t.* 1291, and *Orobus sylvaticus*, *t.* 518. A cluster is most generally drooping or pendulous, and the flowers are all expanded nearly at the same time.

A compound *racemus* occurs in *Solanum Dulcamara*, *t.* 565, and an aggregate one, several being gathered together, in *Actæa racemosa*, *Dill. Elth. t.* 67; but the example of a bunch of Grapes, quoted by Linnæus for a *racemus*, appears to me a true *thyrsus*; see below.

Spica, *f.* 129, a Spike, bears numerous flowers ranged along one common stalk, without any partial stalks, as in *Satyrium hircinum*, *Engl. Bot. t.* 34, *Orchis bifolia*, *t.* 22, *Plantago major*, *t.* 1558, and *media*, *t.* 1559, *Potamogeton heterophyllum*, *t.* 1285, and *fluitans*, *t.* 1286; but this is so seldom the case, that a little latitude is allowed. *Veronica spicata*, *t.* 2, therefore, *f.* 130, and *Ribes spicatum*, *t.* 1290, as well as the Common Lavender, *Lavandula Spica*, are sufficiently good examples of a spike, though none of them has entirely sessile flowers; and Linnæus uses the term in numerous instances where it is still less correctly applicable. A spike generally grows erect. Its mode of expansion is much more progressive than that of the raceme, so that a long period elapses between the fading of the lowest flowers and the opening of the upper ones. The flowers are commonly all crowded close together, or if otherwise, they form separate groups, perhaps whorls, when the spike is said to be either interrupted, or whorled; as in some Mints. In *Sanguisorba officinalis* the spike begins flowering at the top. See *Capitulum* below.

A compound spike is seen in *Lavandula pinnata*, *Curt. Mag. t.* 401; and *L. abrotanoides* of Willdenow.

Spica secunda, a spike whose flowers lean all to one side, occurs in *Nardus stricta*, *Engl. Bot. t.* 290.

Spicula, *f.* 131, a Spikelet, is applied exclusively to grasses that have many florets in one calyx, such florets, ranged on a little stalk, constituting the spikelet, which is therefore a part of the flower itself, and not of the inflorescence; see *Poa aquatica*, *t.* 1315, *fluitans*, *t.* 1520, *Briza minor*, *t.* 1316, &c.

Corymbus, *f.* 132, a Corymb, is a spike whose partial flower-stalks are gradually longer as they stand lower on the common stalk, so that all the flowers are nearly on a level, of which *Spiræa opulifolia*, a common shrub in gardens, is an excellent specimen. The Linnæan class *Tetradynamia* exemplifies this less perfectly, as *Cardamine pratensis*, *Engl. Bot. t.* 776, *Cheiranthus sinuatus*, *t.* 462, and the common Cabbage, *Brassica oleracea*, *t.* 637, in which the *corymbus* of flowers becomes a *racemus* of fruit, as happens also in that section of the *Ve-*

ronicæ, entitled by Linnæus *corymboso-racemosæ*. The flowers of Yarrow, *f.* 133, *Achillea*, *Engl. Bot. t.* 757 and 758, and several others of the compound class, as well as the Mountain Ash, *t.* 337, grow in a corymbose manner, though their inflorescence may not come exactly under the above definition. It is worthy of remark that Linnæus in that definition uses the word *spica*, not *racemus*, nor has he corrected it in his own copy of *Phil. Bot. p.* 41, though he has properly altered a slip of the pen in the same line, *petiolis*, to *pedunculis**. This shows he did not restrain his idea of a spike absolutely to sessile flowers, but admitted that extended signification which nature justifies. Many plants acquire partial stalks as the fruit advances towards maturity.

FASCICULUS, *f.* 134, a Fascicle, is applied to flowers on little stalks, variously inserted and subdivided, collected into a close bundle, level at the top, as the Sweet William, *Dianthus barbatus*, *Curt. Mag. t.* 207, and *D. Armeria*, *Engl. Bot. t.* 317.

CAPITULUM, *f.* 135, a Head or Tuft, bears the flowers sessile in a globular form, as *Statice Armeria*,

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* It might be expected from the numerous learned editors and copiers of this and other works of Linnæus, that they should correct such manifest errors as the above, which any tyro might perceive.

t. 226, *Adoxa Moschatellina*, *t.* 453, and *Gomphrena globosa*, the Globe Amaranthus of the gardens.

Perhaps the inflorescence of *Sanguisorba officinalis*, *t.* 1312, might be esteemed a *capitulum*, because its upper flowers come first to perfection, as in *Adoxa*, which seems contrary to the nature of a spike; but it does not appear that all capitate flowers expand in the same way, and *Sanguisorba canadensis* has a real spike, flowering in the usual manner, from the bottom upwards. So *Allium descendens*, *Curt. Mag. t.* 251, opens its upper, or central, flowers first, contrary to the usual order in its genus; both which instances prove such a diversity to be of small moment.

UMBELLA, an Umbel, for which some authors retain the obsolete old-English name of Rundle. In this several flower-stalks, or rays, nearly equal in length, spread from one common centre, their summits forming a level, convex, or even globose surface, more rarely a concave one. When each ray is simple and single-flowered, it is called a simple umbel, *f.* 136, as those of *Allium ursinum*, *Engl. Bot. t.* 122, Ivy, *t.* 1267, *Primula veris*, *t.* 5, *farinosa*, *t.* 6, *elatior*, *t.* 513, and *Eucalyptus resinifera*, *Exot. Bot. t.* 84. In a compound umbel each ray or stalk mostly bears an *umbellula*, or partial umbel, as *Athamanta Libanotis*, *Engl. Bot. t.* 138. This is usually the case in the very natural order of plants called umbelliferous, *f.* 138, to which the last-mentioned, as well as the common Carrot, Parsnep, Parsley, Hemlock, &c. belongs.

A few only of this order have simple umbels, as *Hydrocotyle vulgaris*, *t.* 751, and the curious *Astrantiæ*, *f.* 137, and *Eriocaliæ*, *Exot. Bot. t.* 76—79. In *Euphorbia* the umbel is differently compounded, consisting of 3, 4, 5 or numerous rays, each of which is repeatedly subdivided, either in a three-fold or forked manner. See *Engl. Bot. t.* 883, 959, &c.

CYMA, *f.* 139, a Cyme, has the general appearance of an umbel, and agrees with it so far that its common stalks all spring from one centre, but differs in having those stalks variously and alternately subdivided. Examples are found in *Viburnum*, *Engl. Bot. t.* 331, 332, and the common Laurustinus, as also in *Sambucus*, Elder, *t.* 475, 476. This mode of inflorescence agrees with a *corymbus* also in general aspect; but in the latter the primary stalks have no common centre, though the partial ones may sometimes be umbellate, which last case is precisely the reverse of a *cyma*.

PANICULA, *f.* 140, a Panicle, bears the flowers in a sort of loose subdivided bunch or cluster, without any order. When the stalks are distant, it is called *diffusa*, a lax or spreading panicle, as in *Saxifraga umbrosa*, *t.* 663, so frequent in gardens under the name of London Pride, and *S. Geum*, *t.* 1561; but particularly in many grasses, as the common cultivated Oat, and *Avena strigosa*, *t.* 1266; in this tribe the branches of the panicle are mostly semi-verticillate; see *Aira aquatica*, *t.* 1557. A divaricated panicle is still more spreading, like those of *Prenanthes muralis*, *t.* 457, and *Spergula arvensis*, *t.* 1535; the last being dichotomous or forked. A dense or crowded panicle, *coarctata*, is observable in *Milium lendigerum*, *t.* 1107, and *Agrostis stolonifera*, *t.* 1532, but still more remarkably in *Phleum paniculatum*, *t.* 1077, whose inflorescence looks, at first sight, like a cylindrical spike, but when bent to either side, it separates into branched lobes, constituting a real panicle.

THYRSUS, *f.* 141, a Bunch, is a dense or close panicle, more or less of an ovate figure, of which the Lilac, *Syringa vulgaris*, *Curt. Mag. t.* 183, *Tussilago hybrida* and *Petasites*, *Engl. Bot. t.* 430, 431, are examples cited by Linnæus. I presume likewise to consider a bunch of grapes, *Vitis vinifera*, as a true *thyrsus*, to the characters and appearance of which it correctly answers. Its ultimate terminations are sometimes obscurely umbellate, especially while in blossom, which is no objection here, but can never be the case in a *racemus*, whether simple or compound. See *Racemus*.

Of simple flower-stalks, whether solitary or clustered, radical or cauline, axillary, lateral or terminal, we have already spoken.

Linnæus remarks that the most elegant specific characters are taken from the inflorescence. Thus the Apple, *Engl. Bot. t.* 179, and the Pear, form two species of *Pyrus*, so far at least a most natural genus, the former of which bears an umbel, the latter a corymb. *Pyrola uniflora, t.* 146, *secunda, t.* 517; and *umbellata, Curt. Mag. t.* 778, are admirably distinguished by their several forms of inflorescence.

CHAPTER XIX.

OF THE FLOWER AND FRUIT.

HAVING examined the general structure and external form of plants, we now come to more important and even essential, though more transitory organs—the flower and fruit, or parts of fructification. By these each species is perpetually renewed without limits, so far at least as the observation of mankind has reached; while, as we have already mentioned, all other modes of propagation are but the extension of an individual, and sooner or later terminate in its total extinction.

Nothing can be more happy than the Linnæan definition of these organs; *Phil. Bot.* 52. "The fructification is a temporary part of vegetables, destined for the reproduction of the species, terminating the old individual and beginning the new."

Pliny had long ago beautifully said that "blossoms are the joy of trees, in bearing which they assume a new aspect, vyeing with each other in the luxuriance and variety of their colours." Linnæus has justly applied this to plants in general, and, improving upon the idea, he considers their herbage as only a mask or clothing, by no means indicative of their true nature or character, which can be learned from the flower and fruit alone.

Mr. Knight has traced his central vessels, by which the sap is conveyed from the root, into the flower and fruit. On the returning sap in the bark of these parts he has not been able to make any distinct observation; but he has determined that no matter of increase is furnished from the flowers or their stalks, as from leaves, to the part of the branch below them, nor indeed to any other part, *Phil. Trans.* for 1801, *p.* 340. There can be no doubt that certain parts of the flower, which we shall presently describe, perform functions respecting air and light analogous to those of leaves, but entirely subservient to the benefit of the flower and fruit. Their secretions, formed from the returning sap, are confined to their own purposes. As soon as these are accomplished, a decided separation of vessels takes place, and the ripe fruit, accompanied perhaps by its stalk, falls from the tree. Dr. Hales tried in vain to give any flavour to fruit by the most penetrating and volatile fluids conveyed through the sap-vessels; for the laws of secretion are absolute in the organs of the flower, and their various results are, if possible, more strikingly distinct than even those we have contemplated in the leaves.

It is scarcely necessary to repeat that the fructification is *essential* to vegetables. A plant may be destitute of stem, leaves, or even roots, because, if one of these parts be wanting, the others may perform its functions, but it can never be destitute of those organs by which its species is propagated. Hence, though many individual plants may be long without blossoms, there are none, so far as nature has been thoroughly investigated, that are not capable, in favourable circumstances, of producing them, as well as seeds; to whose perfection the blossoms themselves are altogether subservient.

Linnæus distinguishes seven parts of fructification, some of which are essential to the very nature of a flower or fruit, others not so indispensably necessary, and therefore not universal.

I. *Calyx*, the Calyx or Flower-cup, generally resembling the leaves in texture and colour, and forming the outermost part of a flower. This is not essential, and is often absent.

II. *Corolla*, the Corolla, or more delicate coloured internal leaf or leaves, properly *petals*, of a flower, likewise not essential.

III. *Stamen*, or *Stamina*, the Stamen or Stamens, commonly of a slender or thread-like form, bearing some kind of knob or cellular body, and ranged internally with respect to the Corolla. These are essential.

IV. *Pistillum*, or *Pistilla*, the Pistil, or Pistils, in the centre of the flower, consisting of the rudiments of the fruit, with one or more organs attached to them, and, of course, essential.

V. *Pericarpium*, the Seed-vessel, of a pulpy, woody, or leathery texture, inclosing the seeds, but wanting in many plants.

VI. *Semen*, the Seed, the perfecting of which is the sole end of all the other parts.

VII. *Receptaculum*, the Receptacle, basis or point of connection. This must necessarily be present in some form or other.

I. CALYX. The flower-cup, or more correctly the external covering of the flower, when present, was originally divided by Linnæus into seven kinds, some of which are more justly so denominated than the others, and I have ventured to make an alteration in his list.

1. *Perianthium*, *f.* 142. Calyx, properly and commonly so called, when it is contiguous to and makes a part of the flower, as the five green leaves which encompass a Rose, including their urn-shaped base; the two green bristly ones which enfold the bud in *Glaucium luteum*, *Fl. Brit. Engl. Bot. t.* 8; the tubular part, comprehending the scales at its base,

in the Pinks, *t.* 61, 62, or the globular scaly cup in *Centaurea*, *t.* 56. The Tulip, *t.* 63, is a naked flower, having no calyx at all.

This part is of an infinite variety of forms in different *genera*, being either simple or compound, divided or undivided, regular or irregular. In some instances it is permanent till the fruit is ripe, in others it falls even before the flower is well expanded.

Some *genera* have a double *perianthium*, as *Malva*, *t.* 671, or even a triple one, as *Scabiosa*, *t.* 1311.

2. *Involucrum*, *f.* 143. Involucre of Professor Martyn; but I generally retain the Latin termination. This is remote from the flower, and can scarcely be distinguished clearly from a *Bractea*. The term was first adopted by Linnæus, at the suggestion of his friend Artedi, in order to distinguish the *genera* of umbelliferous plants, for which purpose the latter deemed the part in question very important. But according to the laws which Linnæus had laid down, the parts of the flower and fruit alone were to afford generic characters, and the most sound botanists have ever since kept to this rule, with infinite advantage over less correct ones, however ready to derive ideas respecting the natural habit, and *secondary* characters, of a genus, not only from the inflorescence and bracteas, but even from the leaves, stipulas, or other parts. Linnæus and Artedi, there-

fore, were obliged to consider the *involucra* and *involucella*, the former accompanying the general and the latter the partial umbels, as a sort of calyx, and the umbel altogether as one aggregate flower, composed of florets united by a common radiated receptacle. Consequently a cyme must be considered in the same light; nor are resons wanting in support of this hypothesis, which we shall consider after having first explained all the parts of fructification.

In *Euphorbia*, however, the term *bractea* would surely be more proper than *involucrum* or *involucellum*, as is evident from a consideration of the inflorescence of the whole genus, so very different in different species. In *E. Peplis*, and many others, the flowers are solitary and axillary; in others again, as *E. amygdaloides*, *Engl. Bot. t.* 256, and *Characias*, *t.* 442, some flower-stalks are umbellate, some scattered; and the subdivisions of the umbel in all are ultimately forked, that is, of a nature between umbellate and scattered. This genus has, moreover, a proper calyx or *perianthium* of a most distinct and peculiar nature. Some species of *Anemone*, a genus destitute of a *perianthium*, are said by Linnæus to have an *involucrum*, as *A. Pulsatilla*, *t.* 51, for which the name of *bractea* would be vastly more correct, though in *A. Hepatica*, *Curt. Mag. t.* 10, it is placed so near the flower as to seem a part of it, which, however, is really not the case.

The name of *Involucrum* is applied by Gleditsch to the membrane covering the fructification of ferns, *f.* 144, 145; nor have I, in studying this part with peculiar attention in order to reform the genera of these plants, see *Tracts relating to Natural History, p.* 215, found reason to contrive any new appellation. My learned friends Willdenow and Swartz have judged otherwise, calling this membrane the *indusium*, or covering; which seems to me altogether superfluous. See its various forms in *Engl. Bot. t.* 1458—60, 1150, 1159, 1160, &c.

3. *Amentum, f.* 146. Catkin, denominated by authors before Linnæus *julus*, *nucamentum*, or *catulus*; consists of a common receptacle of cylindrical form beset with numerous scales, each of which is accompanied by one or more stamens or pistils, so that the whole forms an aggregate flower. The receptacle itself and the bases of the scales are firmly united, and the whole catkin falls off entire, except that in some instances the upper part of each scale withers away, as in the Willow genus, *Salix*, *Engl. Bot. t.* 1388—90, 1402—4, &c., the seed-vessels in that genus being quite distinct from the scales. In others, the whole scale remains, enlarges, hardens, and protects the seed, as in *Pinus*, the Fir tribe. Such is the case with catkins of fertile flowers, which are necessarily permanent till the seed is ripe; barren ones fall as soon as the stamens have per-

formed their office. Every catkin consists generally of either one kind of flower or the other. There are few certain and invariable instances of stamens and pistils in the same catkin, that circumstance occurring chiefly in a few species of *Salix* and *Carex*; nor is *Typha*, *t.* 1455—7, an exception to this. Examples of barren-flowered catkins are seen, not only in *Salix* and *Pinus*, but in several plants whose fertile or fruit-bearing flowers are not catkins, such as the Walnut, and, unless I am much mistaken, the Hasel-nut, *t.* 723. Each nut or seed of the latter has a permanent coriaceous calyx of its own, inadvertently called by Gærtner an *involucrum*, though he considers the whole as an *amentum*, which this very calyx proves it not to be*. *Humulus*, the Hop, *t.* 427, has a catkin for the fertile flower only.

4. *Spatha*, *f.* 147. Sheath, a covering which bursts longitudinally, and is more or less remote from the flower. This is exemplified in the Snow-drop, *Galanthus nivalis*, *Engl. Bot. t.* 19, the various species of *Narcissus*, *t.* 17, 275 and 276, and the *Arum*, *t.* 1298. The *Spatha* of the latter encloses a *Spadix*, or elongated receptacle, common to many

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* It appears moreover that *Carpinus*, the Hornbeam, has hitherto erroneously been supposed to have an *amentum* for the fertile flower. The true nature of the covering of the seed, as well as of the common stalk, proves it otherwise.

flowers, according to the genuine Linnæan idea of this kind of calyx, taken from Palm-trees. In these the *Spadix* is branched.

5. *Gluma*, *f.* 148. Husk, the peculiar calyx of Grasses and Grass-like plants, of a chaffy texture. These husks are usually compressed, embracing each other at the base, as in *Phleum pratense*, *t.* 1076. Sometimes they are depressed, flattened vertically, as in *Briza*, *t.* 540 and 1316. To the husk belongs the *Arista*, *f.* 149, Beard or Awn, a bristle-shaped appendage, usually spiral, and possessing the property of an hygrometer. This, however, is not always present, even in different individuals of the same species.

> " Unfortunately for the science,
> On the awn there's no reliance."

So says, or rather sings, with more truth than sublimity, the ingenious author of the *Flora Londinensis*; *fasc.* 6, *t.* 8.

The spiral kind of awn is most frequently attached to the *Corolla* of grasses, which is precisely of the same husky nature as their calyx, and is, by some botanists, considered as such. Specimens of *glumæ muticæ*, beardless husks, are seen in *Phalaris canariensis*, *Engl. Bot.* *t.* 1310, and *glumæ aristatæ*, awned ones, in *Lagurus ovatus*, *t.* 1334, and *Stipa pennata*, *t.* 1356.

6. *Perichætium*, *f.* 150. A scaly Sheath, investing the fertile flower, and consequently the base of the fruit-stalk, in some Mosses. In the genus *Hypnum* it is of great consequence, not only by its presence, constituting a part of the generic character, but by its differences in shape, proportion, and structure, serving frequently to discriminate species. See *Engl. Bot. t.* 1037—9, 1182, 1445—8, &c.; see also the same part in *Neckera*, *t.* 1443, 4. Linnæus appears by his manuscripts to have intended adding this to the different kinds of calyx, though it is not one of the seven enumerated in his printed works. Nor is he, surely, correct in allowing it to the genus *Jungermannia*. The membranous part which he there calls *perichætium* is strictly analogous indeed to the *calyptra*, *f.* 151, 152 b, or veil of real mosses, esteemed by him a kind of calyx; but as I presume with Schreber, to reckon it rather a corolla, and Hedwig once thought the same, and as *Jungermannia* has more or less of a real calyx besides, *f.* 152 a, see *Engl. Bot. t.* 771, &c., I would no longer apply the term *perichætium* to this genus at all.

The part called *calyptra* being removed from the list, as being a corolla, the *perichætium* takes its place among the seven kinds of calyx. We lay less stress upon this coincidence than Linnæus might have done, when, according to the fashion of the times, he condescended to distribute his immortal

Philosophia Botanica into 12 chapters and 365 sections, and reckoned seven parts of fructification as well as seven species of calyx.

7. *Volva*, *f.* 153. Wrapper, or covering of the *Fungus* tribe, of a membranous texture, concealing their parts of fructification, and in due time bursting all round, forming a ring upon the stalk, as in *Agaricus procerus*, *Sowerb. Fung. t.* 190, and *A. campestris*, the Common Mushroom, *t.* 305; such at least is the original meaning of this term, as explained in the *Phil. Bot.*; but it has become more generally used, even by Linnæus himself, for the more fleshy external covering of some other *Fungi*, which is scarcely raised out of the ground, and enfolds the whole plant when young, *f.* 154. See *Agaricus volvaceus*, *Sowerb. t.* 1, and *Lycoperdon fornicatum*, *t.* 198; also the very curious *L. phalloides*, *t.* 390, now made a distinct genus by the learned Persoon, under the name of *Batarrea phalloides*.

Linnæus adopted from Cæsalpinus the opinion that the *Calyx* proceeded from the bark, like the leaves, because of its similarity in colour and texture to those organs. He even refined upon the original idea, and supposed this part to proceed from the outer bark, while the more delicate *corolla* originated in the *liber*. What is now known of the physiology of the bark, as explained in several of our preceding chapters, renders this hypothesis totally inadmissible.

The knowledge of the real use of leaves, see *chapter* 16, may however throw some light upon that of the calyx. Besides protection of the flower from external injuries, which is one evident use of this part, it appears highly probable that it may often contribute to the growth and strength of the stalk which supports it, as the leaves do to that portion of branch below them. The stalk often swells considerably during the growth of the flower, especially just below the calyx, becoming more woody, an alteration frequently necessary for the support of the ripening fruit. When the calyx falls very early, as in the Poppy tribe, *Papaver* and *Glaucium*, I cannot find that the flower-stalk is subsequently enlarged, nor in any manner altered; while in genera without number, whose calyx is permanent, the stalk becomes not only more woody, but often considerably thickened.

II. Corolla. The Corolla, vulgarly called the leaves of the flower, consists of those more delicate and dilated, generally more coloured leaves, which are always internal with respect to the calyx, and constitute the chief beauty of a flower. In the Rose the Corolla is red and fragrant; in the Violet purple; in the Primrose yellow.

This term includes two parts, the Petal, *Petalum*, and the Nectary, *Nectarium*. The former is either simple, as in the Primrose, in which case the Corolla is said to be monopetalous, of one petal; or compound, as in the Rose, in which it is polypetalous, of several. The Nectary is sometimes a part of the petal, sometimes separate from it.

A monopetalous Corolla consists of two parts; the tube, *tubus*, the cylindrical part enclosed in the calyx of the Primrose; and the limb, *limbus*, which is the horizontal spreading portion of the same flower, *f.* 155. The analogous parts of a polypetalous Corolla, as in the Wall-flower or Stock, *f.* 156, are named the claw, *unguis*, *f.* 157 a, and the border, *lamina*, b.

The Corolla is infinitely diversified in form in different *genera*, whence Tournefort and Rivinus derived their methods of arrangement. It is called regular when its general figure is uniform, as in the Rose, the Pink, the Columbine, *Aquilegia vulgaris*, *Engl. Bot. t.* 297, and *Gentiana Pneumonanthe*, *t.* 20; irregular when otherwise, as the Violet, *t.* 619, 620, Dead-nettle, *t.* 768, and *Lathyrus*, *t.* 805 and 1108. An equal Corolla, *f.* 156, is not only regular, but all its divisions are of one size, like those of the Primrose, *t.* 5, *Campanula*, *t.* 12, or *Saxifraga*, *t.* 9; an unequal one, *f.* 158, is when some segments are alternately smaller than the others, as in *Butomus*, *t.* 651, or otherwise different, as in *Aquilegia*, *t.* 297. It is by no means always necessary, in defining characters of genera, to use these last terms, it being sufficient in general to say that a Corolla is regular in opposition to one that is irregular; more especially as some species of a genus may possibly have an equal corolla, others an unequal one.

The most usual shapes of a monopetalous corolla are

campanulata, *f.* 159, bell-shaped, as in *Campanula*, *t.* 12.

infundibuliformis, *f.* 160, funnel-shaped, *Pulmonaria*, *t.* 118.

hypocrateriformis, *f.* 155, salver-shaped, *Primula*, *t.* 4.

rotata, wheel-shaped, that is, salver-shaped with scarcely any tube, *Borago*, *t.* 36.

ringens, *f.* 161, ringent, irregular and gaping like the mouth of an animal, *Lamium*, *t.* 768; called by former botanists *labiata*, lipped.

personata, *f.* 162, personate, irregular and closed by a kind of palate, *Antirrhinum*, *t.* 129.

Those of a polypetalous one are

cruciformis, *f.* 156, cruciform, regular and like a cross, *Dentaria*, *t.* 309, and *Cheiranthus*, *t.* 462.

rosacea, rosaceous, spreading like a rose, *Dryas*, *t.* 451.

papilionacea, *f.* 163, papilionaceous, irregular and spreading, somewhat like a butterfly, *Lathyrus*, *t.* 1108. The various petals which compose such a flower are distinguished by appropriate names, as *vexillum*, *f.* 164, standard, the large one at the back; *alæ*, *f.* 165, wings, the two side petals; and *carinâ*, *f.* 166, the keel, consisting of two petals, united or separate, embracing the internal organs, *f.* 167. In *Trifolium* all the petals are sometimes united into one at the lower part.

incompleta, incomplete, when parts, which analogy would lead us to expect, are deficient, as in *Amorpha*, a papilionaceous flower apparently, but consisting of the *vexillum* only; or *Rittera* of Schreber, *f.* 168, a rosaceous one with a single lateral petal, seeming as if four others had been stripped off.

It is remarkable that irregular flowers sometimes vary to regular ones in the very same plant, as in *Bignonia radicans*, *Curt. Mag. t.* 485; and *Antirrhinum Linaria*, *f.* 169, *Engl. Bot. t.* 658 and 260.

Linnæus was of opinion that the Corolla originated from the *Liber* or inner bark, as the Calyx from the outer, but this cannot be defended now the real physiology of the bark is better understood.

The whole use and physiology of the Corolla have not yet been fully explained. As a protection to the tender and important parts within, especially from wet, its use in many cases is obvious, but by no means in all. Linnæus imagined it to serve as wings, to waft the flower up and down in the air, and so to promote the functions of the Stamens and Pistils, as will hereafter be described; nor is this opinion unfounded, Sprengel has ingeniously demonstrated, in some hundreds of instances, how the Corolla serves as an attraction to insects, indicating by various marks, sometimes perhaps by its scent, where they may find honey, and accommodating them with a convenient resting-place or shelter while they extract it. This elegant and ingenious theory receives confirmation from almost every flower we examine. Proud man is disposed to think that

"Full many a flower is born to blush unseen,"

because he has not deigned to explore it; but we find that even the beauties of the most sequestered wilderness are not made in vain. They have myriads of admirers, attracted by their charms, and rewarded with their treasures, which very treasures would be as useless as the gold of a miser to the plant itself, were they not thus the means of bringing insects about it. The services rendered by such visitants will be understood when we have described all the parts of a flower.

Besides the above purposes, I have always conceived the Corolla to fulfil some important office to the essential parts of the flower with respect to air, and especially light. It not only presents itself in a remarkable manner to the sun-beams, frequently closing or drooping when they are withdrawn, but it is so peculiarly distinguished by beauty or brilliancy of colour, that one cannot but think its functions somewhat different from those of the leaves, even with regard to light itself. Dr. Darwin calls the Corolla the lungs of the stamens and pistils, and with great probability, for they abound in air-vessels. But when we consider the elaborate and peculiar secretions of a flower, the elastic inflammable *pollen*, the honey, and the exquisitely volatile perfume, as we know from the curious discoveries of modern chemistry how great a share light has in the production of such, we cannot but conclude that the petals must be of primary importance with respect to their secretion by its means.

Sometimes the Corolla is very short-lived; sometimes very lasting, even till the fruit is perfected, though mostly in a faded condition. In double flowers I have observed it to be much more durable than in single ones of the same species, as Anemonies and Poppies, because, as I conceive, of its not having performed its natural functions, the stamens and pistils of such flowers being obliterated, or changed to petals; hence the vital principle of their corolla is not so soon exhausted as usual. *Phil. Trans. for* 1788, *p.* 165.

The Corolla, as already mentioned, is not essential. Whatever its functions may be, they can be occasionally performed by the Calyx perhaps, or even by the Filaments of the Stamens; as those of leaves are, in leafless plants, by the stems. When a flower has only one covering, it is not always easy to say whether that be a Calyx or Corolla. When green and coarse in texture, like the former, we call it so, as in *Chenopo-*

dium, *Engl. Bot. t.* 1033, and 1721—4, and the natural relationship of this genus to *Polygonum*, *t.* 1044, 989, 756, &c., leads us to reckon the same part in the latter a coloured calyx. On the other hand, when the part present is delicate and finely coloured, like the generality of Corollas, we denominate it such; more especially if the plant to which it belongs be allied to others that have a Calyx besides, as in *Tulipa*, *t.* 63, allied to *Leucojum*, *t.* 621, which has a *Spatha*. The great Jussieu denominates this part in the Tulip and other liliaceous plants, however beautiful, a Calyx. His definition of a Corolla is "that covering of a flower which is invested with the Calyx, being very rarely naked; a continuation of the inner bark of the flower-stalk, not of its cuticle; not permanent, but mostly falling off from the stamens; surrounding or crowning the fruit, but never growing united with it; and having its parts or segments for the most part alternate with the stamens, which are equal to them in number." By this rule the tube and six segments of a *Narcissus*, *t.* 17, 275 and 276, constitute the Calyx, and then surely what Jussieu calls a Crown, *f.* 1476, and Linnæus a Nectary, must be allowed the name of Corolla. On the other hand, the *Spatha* becomes a *Bractea*. Consequently the whole order of Liliaceous flowers in general have a coloured Calyx only, which seems hardly admissible; and yet I cannot conceal a recent discovery which strongly confirms the opinion of my acute and candid friend. Two species of a new genus*, found by Mr. Menzies on the West coast of North America, have beautiful liliaceous flowers like an *Agapanthus*, with three internal petals besides! *Tulbaghia* is a similar instance. I must however protest against the idea of the Corolla originating exclusively from the inner bark, as well as of the cuticle not being continued over it, for reasons sufficiently apparent from the former part of this work.

It is a Linnæan rule that the Stamens should be opposite to the segments of the Calyx, and alternate with the parts of the Corolla. Its author nevertheless seems of opinion that no absolute means of distinction between these two parts can be pointed out, except colour; of the insufficiency of which he is aware. If however the Corolla performs functions with respect to light which the Calyx does not, and those functions are indicated by its colour, a distinction founded on such a principle is both correct and philosophical. We must then conclude that in *most* liliaceous plants, not in *all*, the two organs are united into one, and indeed the outside is often green and coarse like a Calyx, the inner coloured and delicate; witness *Ornithogalum*, *t.* 21, 130 and 499, *Narthecium*, *t.* 535, &c. Linnæus has the same idea respecting *Daphne*, *t.* 119 and 1381, and the analogy is confirmed by *Gnidia*, which is a *Daphne* with petals. In *Trollius*, *t.* 28, and *Helleborus*, *t.* 200 and 613, Linnæus considers as Petals what Jussieu, following Vaillant, thinks a Calyx. Of these plants we shall soon have occasion to speak again.

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* I have lately, in a paper to the Linnæan Society, named this genus *Brodiæa* in honour of James Brodie, Esq. F.L.S. See *Tr. of Linn. Soc. v.* 10. 1.

I cannot but consider as a sort of Corolla the *Calyptra* or Veil of Mosses, which Linnæus reckoned a Calyx. Schreber, very deep and critical in his inquiries concerning these plants, and Hedwig, so famous for his discoveries among them, were both of this opinion, though the latter seems to have relinquished it. The organ in question is a membranous hood, covering the unripe fruit of these diminutive vegetables, like an extinguisher, *f.* 151; but soon torn from its base, and elevated along with the ripening capsule. See *Engl. Bot. t.* 558, &c. The great peculiarity of this part, whatever it be called, consists in its summit performing the office of a stigma, as Hedwig first remarked. In *Jungermannia*, *f.* 152, *t.* 771, &c., the very same part, differing only in usually bursting at the top to let the fruit pass, is named by Linnæus a *perichætium*, but very incorrectly, as we have already hinted.

Whatever office the petals may perform with respect to air and light, it is probable that the oblong summit of the *Spadix* in *Arum*, *t.* 1298, answers the same purpose. When this part has been for a short time exposed to the light, it assumes a purplish brown hue, which M. Senebier seems to attribute to the same cause which he thinks produces the great heat observed in this flower, the rapid combination of oxygen gas with the carbon of the plant; an hypothesis hardly adequate to explain either.

Nectarium, the Nectary, may be defined as that part of the Corolla which contains or which secretes honey. It is perhaps in effect nearly universal, as hardly a flower can be found that has not more or less honey, though that liquor is far from being universally, or even generally, formed by an apparatus separate from the Petals. In monopetalous flowers, as *Lamium album*, the Dead Nettle, *t.* 768, the tube of the corolla contains, and probably secretes, the honey, without any evident Nectary. Sometimes the part under consideration is a production or elongation of the Corolla, as in Violets; sometimes indeed of the Calyx, as in the Garden Nasturtium, *Tropæolum*, *Curt. Mag. t.* 23 and 98, whose coloured Calyx, *f.* 170, partakes much of the nature of the petals. Sometimes it is distinct from both, either resembling the petals, as in *Aquilegia*, *f.* 171, *Engl. Bot. t.* 297, or more different, as in *Epimedium*, *f.* 172, 173, *t.* 438, *Helleborus*, *t.* 200 and 613, *Aconitum*, the common Monkshood, and *Delphinium*, the Larkspur. Such at least is the mode in which Linnæus and his followers understand the four last-mentioned flowers; but we have already hinted that Jussieu is of a different opinion, and he even calls the decided Nectary of *Epimedium* an internal petal! Difficulties attend both theories. It seems paradoxical to call petals those singular bodies in *Aco-*

nitum, *f.* 174, like a pair of little birds, which are manifestly formed only to hold the honey, and not situated nor constructed so as to perform the proper functions of petals; but on the other hand *Ranunculus*, *Engl. Bot. t.* 100, 515 and 516, one of the same natural order, has evident calyx and petals, which latter have a honey-bearing pore in their claw, evincing their identity with the less petal-like Nectaries just described. Other instances indeed of Nectaries in the claws of petals are found in the Crown Imperial and Lily; which only confirms more strongly the compendious construction of the Lily tribe, the leaves of their flowers in these examples being Calyx, Petals and Nectaries all in one.

The most indubitable of all Nectaries, as actually secreting honey, are those of a glandular kind. In the natural order of Cruciform plants, composing the Linnæan class *Tetradynamia*, these are generally four green glands at the base of the Stamens. See *Dentaria*, *Engl. Bot. t.* 309, *Sisymbrium*, *t.* 525, and *Brassica*, *t.* 637. In *Salix*, *t.* 1488, and *Geranium*, *t.* 322, 75, &c., similar glands are observable; whilst in *Pelargonium*, the African Geranium, the Nectary is a tube running down one side of the flower-stalk.

The elegant *Parnassia*, *t.* 82, of which we are now acquainted with two new American species, has a most elaborate apparatus called by Linnæus Nectaries, *f.* 175, but which the cautious Jussieu names Scales only. Linnæus usually called every supernumerary part of a flower Nectary, from analogy alone, though he might not in every case be able to prove that such parts produced honey. This is convenient enough for botanical distinctions, though perhaps not always right in physiology; yet there is nothing for which he has been more severely and contemptuously censured. He was too wise to answer illiberal criticism, or he might have required his adversaries to prove that such parts were not Nectaries. Sometimes possibly he may seem to err, like L'Heritier, in calling abortive stamens by this name. Yet who knows that their filaments do not secrete honey, as well as the tubes of numerous flowers? And though abortive as to Antheras, the Filament, continuing strong and vigorous, may do its office.

Honey is not absolutely confined to the flower. The glands on the footstalks of Passion-flowers yield it, and it exudes from the flower-stalks of some liliaceous plants.

The sweet viscid liquor in question has given rise to much diversity of opinion respecting its use. Pontedera thought it was absorbed by the seeds for their nourishment while forming, as the yolk of the egg by the chick. But Linnæus observes in reply, that barren flowers produce it as well as fertile ones, witness *Urtica* and *Salix*. In some instances the fertile flowers only are observed to bear honey, as *Phyllanthus* and *Tamus*, but such cases are rare. Even Darwin says the honey is the food of the stamens and pistils, not recollecting that it is often lodged in spurs or cells quite out of their reach.

There can be no doubt that the sole use of the honey with respect to the plant is to tempt insects, who in procuring it fertilize the flower, by disturbing the dust of the Stamens, and even carry that substance from the barren to the fertile blossoms.

3. **Stamina.** The Stamens, formerly called Chives, are various in number in different flowers, from one to some hundreds. Their situation is *internal* with respect to the parts we have been describing; *external* to the Pistils, at least in simple flowers.

These organs are essential, there being no plant hitherto discovered, after the most careful research, that is destitute of them, either in the same flower with the pistils, or a separate one of the same species.

A Stamen, *f.* 176, commonly consists of two parts, the Filament, a, *Filamentum*, and Anther, b*, *Anthera*, the former being merely what supports the latter, which is the only essential part. Various forms and proportions of Filaments may be seen in the Tulip, where they are six in number, thick and short, *Engl. Bot. t.* 63; the Pink, where they are ten, much more slender, and answering to the idea of a filament or thread, *t.* 62; and *Anemone*, *t.* 51, where they are numerous. They are commonly smooth, but sometimes, as in *Verbascum*, *t.* 58, 59, bearded. In *Melaleuca*, *Exot. Bot.* *t.* 36 and 50, they are branched; and in *Prunella*, *Engl. Bot. t.* 961, forked, one point only bearing an Anther. In *Aristolochia*, *t.* 398, they are wanting, and nearly so in *Potamogeton*, *t.* 376, &c.

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* I submit to the opinion of Professor Martyn in adopting this word, for the reasons given in his *Language of Botany*, more especially as general practice seems to favour its use.

The Anther is the only essential part of a Stamen. It is generally of a membranous texture, consisting of two cells or cavities, bursting longitudinally at their outer edges, as in the Tulip. In *Erica*, *t.* 1013—15, it opens by pores near the summit, as in the Potatoe-blossom. Very rarely the Anther has four cells, as *Tetratheca*, *Bot. of N. Holl. t.* 5, and *Exot. Bot. t.* 20*—22. Sometimes it is ornamented with a crest, as in many *Ericæ*, and the genus *Pinus*. See Mr. Lambert's splendid work.

The *Pollen*, or Dust, is contained in the Anther, from which it is thrown out chiefly in warm dry weather, when the coat of the latter contracts and bursts. The Pollen, though to the naked eye a fine powder, and light enough to be wafted along by the air, is so curiously formed, and so various in different plants, as to be an interesting and popular object for the microscope. Each grain of it is commonly a membranous bag, round or angular, rough or smooth, which remains entire till it meets with any moisture, being contrary in this respect to the nature of the Anther; then it bursts with great force, discharging a most subtile vapour. In the Orchis family, and some other plants, the pollen is of a glutinous nature, very different from its usual aspect. See remarks on *Mirabilis longiflora*, *Exot. Bot. v.* 1. 44.

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* In this plate the engraver has by mistake expressed the section of the anther so as to look more like a germen, though the original drawing was correct.

The Stamens are changed to petals in double flowers, and rendered useless. They are often obliterated by excessive nourishment, or when the plant increases much by root, as in the Fiery Lily, or true *Lilium bulbiferum*.

4. PISTILLA. The Pistils, no less essential than the Stamens, stand within them in the centre of the flower, and are generally fewer. When in a different flower, on the same or a different plant, they are not always central. Linnæus conceived them to originate from the pith, and the stamens from the wood, and hence constructed an ingenious hypothesis, relative to the propagation of vegetables, which is not destitute of observations and analogies to support it, but not countenanced by the anatomy and physiology of the parts alluded to.

Each Pistil, *f.* 177, consists of three parts. 1, the *Germen*, a, or rudiment of the young fruit and seed, which of course is essential; 2, the *Stylus*, b, style, various in length and thickness, sometimes altogether wanting, and when present serving merely to elevate the third part, *Stigma*, c. This last is indispensable. Its shape is various, either simple, scarcely more than a point, or capitate, forming a little round head, or variously lobed. Sometimes hollow, and gaping more especially when the flower is in its highest perfection; very generally downy, and always more or less moist with a peculiar viscid fluid, which in some plants is so copious as to form a large drop, though never big enough to fall to the ground. The moisture is designed for the reception of the pollen, which explodes on meeting with it; and hence the seeds are rendered capable of ripening, which, though in many plants fully formed, they would not otherwise be.

The Germen appears under a variety of shapes and sizes. It is of great moment for botanical distinctions to observe whether it be superior, that is, above the bases of the calyx and corolla, as in the Strawberry and Raspberry, or inferior, below them, as in the Apple and Pear. Very rarely indeed the Germen is supposed to be betwixt the calyx and corolla, of which *Sanguisorba*, *Engl. Bot. t.* 1312, is reckoned by Linnæus an example; but the corolla there has really a tube, closely embracing the Germen. In *Adoxa*, *t.* 453, the calyx is half-inferior, the corolla superior. When in botanical language we say *germen superior*, it is equivalent to *flower inferior*; but it is sometimes more convenient and proper, for the sake of analogy or uniformity, to use one mode of expression than the other.

Pistils are sometimes obliterated, though oftener changed to petals, in double flowers, as well as the stamens; but I have met with a much more remarkable change in the Double Cherry, of the pistil into a real leaf, exactly conformable to the proper leaves of the tree, only smaller. By this we may trace a sort of round in the vegetable constitution. Beginning at the herbage or leaves, we proceed insensibly to bracteas in many species of *Salvia*, or to both calyx and corolla in the Garden Tulip, which frequently has a leaf half green half coloured, either in the flower or on the stalk just below it. *Anemone alpina* produces occasionally a petal among the segments of its involucrum or bractea. *Geum rivale*, *Engl. Bot. t.* 106, when cultivated in dry gravelly ground, exhibits such transformations in abundance. Between petals and stamens there is evidently more connection, as to their nature and functions, than between any other organs, and they commonly flourish and fall together. Yet only one instance is known of petals changing to stamens, which Dr. Withering has commemorated, in the Black Currant, *Ribes nigrum*. On the other hand, nothing is more frequent than the alteration of stamens to petals. Here then the metamorphosis begins to be retrograde, and it is still more so in the Cherry above mentioned, by which we return to the herbage again.—The line of distinction seems to be most absolute between stamens and pistils, which never change into each other; on the contrary, pistils, as we see, rather turn into petals, or even into leaves.

5. **Pericarpium.** The seed-vessel, extremely various in different plants, is formed of the germen enlarged. It is not an essential part, the seeds being frequently naked, and guarded only by the calyx, as in the first order of the Linnæan class *Didynamia*, of which *Lamium*, *Engl. Bot. t.* 768, and *Galeopsis*, *t.* 667, are examples; also in the great class of compound flowers, *Syngenesia*, as well as in *Rumex*, *t.* 724, *Polygonum*, *t.* 989, the Umbelliferous tribe, numerous Grasses, &c.

The use of the Seed-vessel is to protect the seeds till ripe, and then in some way or other to promote their dispersion, either scattering them by its elastic power, or serving for the food of animals in whose dung the seeds vegetate, or promoting the same end by various other means. The same organ which remains closed so long as it is juicy or moist, splits and flies asunder when dry, thus scattering the seeds in weather most favourable for their success. By an extraordinary provision of Nature, however, in some annual species of *Mesembryanthemum*, *f.* 178, natives of sandy deserts in Africa, the seed-vessel opens only in rainy weather; otherwise the seeds might, in that country, lie long exposed before they met with sufficient moisture to vegetate.

1. *Capsula*, a Capsule, is a dry seed-vessel of a woody, coriaceous or membranous texture, generally splitting into several valves; more rarely discharging its contents by orifices or pores, as in *Campanula* and *Papaver*; or falling off entire with the seed. Internally it consists either of one cell or several; in the latter case the parts which separate the cells are called *dissepimenta*, partitions. The central column to which the seeds are usually attached is named *columella*. See *Datura Stramonium*, *f.* 179, *Engl. Bot. t.* 1288.

Gærtner, a writer of primary authority on fruits and seeds, reckons several peculiar kinds of Capsules, besides what are generally understood as such; these are

Utriculus, a Little Bladder, which varies in thickness, never opens by any valves, and falls off with the seed. I believe it never contains more than one seed, of which it is most commodiously, in botanical language, called an external coat, rather than a Capsule. Gærtner applies it to *Chenopodium*, as well as to *Clematis*, &c. In the former it seems a *Pellicula*, in the latter a *Testa*, as we shall hereafter explain.

Samara is indeed a species of Capsule, of a compressed form and dry coriaceous texture, with one or two cells, never bursting, but falling off entire, and dilated into a kind of wing at the summit or sides. It is seen in the Elm, the Maple, the Ash, *Engl. Bot. t.* 1692, and some other plants. This term however may well be dispensed with, especially as it is the name of a genus in Linnæus; an objection to which *Cotyledon* too is liable.

Folliculus, a Follicle or Bag, reckoned by Linnæus a separate kind of seed-vessel from the Capsule, ought perhaps rather to be esteemed a form of the latter, as Gærtner reckons it. This is of one valve and one cell, bursting lengthwise, and bearing the seeds on or near its edges, or on a receptacle parallel therewith. Instances are found in *Vinca, t.* 514, *Pæonia, t.* 1513, and *Embothrium, Bot. of New Holland, t.* 7—10.

Coccum of Gærtner, separated by him from capsules, is a dry seed-vessel, more or less aggregate, not solitary, whose sides are elastic, projecting the seeds with great force, as in *Euphorbia*; also *Boronia, Tracts on Nat. History, t.* 4—7. This seems by no means necessary to be esteemed otherwise than a sort of capsule.

2. *Siliqua, f.* 180, a Pod, is a long dry solitary seed-vessel of two valves, separated by a linear receptacle, along each of whose edges the seeds are ranged alternately, as in the class *Tetradynamia*. See *Cheiranthus, Engl. Bot. t.* 462, and *Cardamine, t.* 80; also

Bignonia echinata, figured by Gærtner, *t.* 52, *f.* 1, which, though cautiously called by him a *capsula siliquosa* only, is as true a *Siliqua*, according to his own definition, and every body's ideas, as possible; so is also that of *Chelidonium*. He justly indeed names the fruit of *Pæonia*, *capsula leguminosa*, a follicle with him being a single-valved capsule, with the seeds marginal as in a legume.

Silicula, *f.* 181, a Pouch, is only a Pod of a short or rounded figure, like *Draba verna*, *Engl. Bot. t.* 586.

3. *Legumen*, *f.* 182, a Legume, is the peculiar solitary fruit of the Pea kind, formed of two oblong valves, without any longitudinal partition, and bearing the seeds along one of its margins only. See *Engl. Bot. t.* 1046, 805, &c. The Tamarind is a Legume filled with pulp, in which the seeds are lodged. The Capsules of *Helleborus* and some other plants allied thereto, justly indicated by Gærtner as approaching very nearly to the definition of Legumes, differ essentially in not being solitary, and in consisting each but of one valve. Some Larkspurs indeed bear such capsules solitary, but analogy teaches us their true nature.

When a Legume is divided into several cells, it is either by transverse constrictions, or by inflexion of the valves; never by a separate longitudinal partition; see *Dolichos purpureus*, *Exot. Bot. t.* 74.

Sometimes this kind of fruit lodges but one seed, as in many species of *Trifolium*; see *Engl. Bot. t.* 1048, also *Viminaria denudata*, *Exot. Bot. t.* 27. It is only by analogy that such are known to be Legumes.

4. *Drupa*, *f.* 183, a Stone-fruit, has a fleshy coat, not separating into valves, containing a single hard and bony Nut, to which it is closely attached; as in the Peach, Plum, Cherry, &c.; see *Engl. Bot. t.* 706 and 1383. The Cocoa-nut is a *Drupa* with a less juicy coat.

Sometimes the Nut, though not separating into distinct valves, contains more than one cell, and consequently several seeds. Instances are found in *Cornus*, *t.* 249, *Gærtner*, *t.* 26, and *Olea*, the Olive, *Fl. Græc. t.* 3, though one cell of the latter is commonly abortive.

5. *Pomum*, *f.* 184, an Apple, has a fleshy coat like the *Drupa*, but containing a Capsule with several seeds, as in common Apples and Pears; see *Pyrus domestica*, *t.* 350.

This is comprehended by Gærtner under the different kinds of *Bacca*, it being sometimes scarcely possible to draw the line between them; witness the Linnæan genus *Sorbus*.

6. *Bacca*, *f.* 185, a Berry, is fleshy, without valves, con-

taining one or more Seeds, enveloped with pulp. It becomes more juicy internally as it advances to maturity, quite contrary to the nature of a Capsule, though the difference between these two unripe fruits may not be discernible, and though some true Berries, when fully ripe, finally become of a dry and spongy texture; but they never open by valves or any regular orifice. Examples of a *Bacca* are seen in *Atropa Belladonna*, *Engl. Bot. t.* 592, and *Ribes*, *t.* 1289—92. The same part in *Hedera*, *t.* 1267, is of a more mealy substance. In *Cucubalus*, *t.* 1577, the coat only is pulpy. In *Trientalis*, *t.* 15, the coat becomes very dry and brittle as soon as ripe, and the cavity of the fruit is nearly filled by a globular *columella*. See Gærtner, *t.* 50.

Bacca composita, *f.* 186, a Compound Berry, consists of several single ones, each containing a seed, united together, as in *Rubus*, the Raspberry, Bramble, &c., *Engl. Bot. t.* 715, 716, 826, 827. Each of the separate parts is denominated an *Acinus*, or Grain, which term Gærtner extends to the simple many-seeded berries of the Vine, Gooseberry, &c.

The Orange and Lemon are true Berries, with a thick coat. The Melon and Cucumber tribe have a peculiar sort of Berry, for which Gærtner uses the name of *Pepo*, Gourd; and he defines it a Berry whose cells, together with the seeds, are remote from the *axis* or centre, the seeds being inserted into the sides of the fruit. *Passiflora suberosa*, *f.* 187, *Exot. Bot. t.* 28, shows this insertion, being nearly allied to the same tribe; but in this genus the pulp invests each seed separately, forming *Acini* within the common cavity.

Some fruits ranged by Linnæus as *Drupæ* with many seeds, on account of the hardness of the shells of those seeds, are best perhaps, on account of their number, considered by Gærtner as *Baccæ*. Among these are *Mespilus*, the Medlar.

There are several spurious kinds of berries, whose pulp is not properly a part of the fruit, but originates from some other organ. Thus, in the Mulberry, as well as the Strawberry, Spinach, *Blitum*, *Curt. Mag. t.* 276, the Calyx after flowering becomes coloured and very juicy, investing the seed, like a genuine berry. The Corolla of *Commelina Zanonia* undergoes a similar change, forming a black very juicy coat to the capsule, being totally altered both in shape and substance from its appearance in the flower. In the Juniper, *Engl. Bot. t.* 1100, a few scales of the fertile catkin become succulent, and coalesce into a globular berry with three or more seeds, to which Gærtner applies the term *galbulus*, the classical name of the Cypress fruit, which last however is as true a *strobilus* or cone as that of the Fir. In the Yew, *t.* 746, some have thought it a calyx, others a peculiar kind of receptacle, which becomes red and pulpy, embracing the seed. Lamarck has, in his *Encyclopédie*, *v.* 3. 228, considered this fruit as a real *bacca* or *drupa*, with the idea or definition of either of which it cannot by any means be made to accord, being open at the top, and having no connection with the *stigma*, which crowns the seed itself. The same writer mistakes for a calyx the scales, which analogy shows to be bracteas; and I cannot but think Jussieu and Gærtner more correct in their ideas of this singular fruit, when they call the pulpy part in question a receptacle, though the term calyx seems less paradoxical, and is perhaps still more just*. We do not know enough of *Taxus nucifera* to draw any conclusions from thence. See *Gærtner*, *t.* 91. In the Strawberry, *Engl. Bot. t.* 1524, what is commonly called the berry is a pulpy receptacle, studded with naked seeds. In the Fig, *Gærtner*, *t.* 91, the whole fruit is a juicy calyx, or rather common receptacle, containing in its cavity innumerable florets, each of which has a proper calyx of its own, that becomes pulpy and invests the seed, as in its near relation the Mulberry. The Paper Mulberry of China is indeed an intermediate genus between the two, being as it were a Fig laid open, but without any pulp in the common receptacle.

7. *Strobilus*, *f.* 188, a Cone, is a Catkin hardened and enlarged into a Seed-vessel, as in *Pinus*, the Fir.

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* *Hernandia, Gærtn. t.* 40, has a similar, though not succulent, calyx, and the green cup of the Hazel-nut is equivalent to it.

In the most perfect examples of this kind of fruit the Seeds are closely sheltered by the scales as by a capsule, of which the Fir, Cypress, &c., are instances. In the Birch and Alder they have a kind of capsule besides, and in the Willow and Poplar a stalked bivalve capsule, still more separate from the scales. The Plane-tree, *Platanus*, the *Liquidambar* and the *Comptonia*, have globular catkins, in which bristles or tubercles supply the place of scales. See *Gærtner*, *t.* 90.

6. Semina. The Seeds are the sole "end and aim" of all the organs of fructification. Every other part is, in some manner, subservient to the forming, perfecting, or dispersing of these. A seed consists of several parts, some of which are more essential than others, and of these I shall speak first.

Embryo, *f.* 2, 4, the Embryo, or Germ, is the most essential of all, to which the rest are wholly subservient, and without which no seed is perfect, or capable of vegetation, however complete in external appearance. Linnæus, after Cæsalpinus, names it the *Corculum*, or Little Heart, and it is the point whence the life and organization of the future plant originate, as we have already explained, *p.* 74. In some seeds it is much more conspicuous than in others. The Walnut, the Bean, Pea, Lupine, &c., show the Embryo in perfection. Its internal structure, before it begins to vegetate, is observed by

Gærtner to be remarkably simple, consisting of an uniform medullary substance, enclosed in its appropriate bark or skin. Vessels are formed as soon as the vital principle is excited to action, and parts are then developed which seemed not previously to exist, just as in the egg of a bird. In position, the Embryo is, with respect to the base of the whole flower or fruit, either erect, as in the Dandelion and other compound flowers, reversed as in the Umbelliferous tribe, or horizontal as in the Date Palm, *f.* 199 b, *Gærtner, t.* 9. In situation it is most commonly within the substance of the seed, and either central as in Umbelliferous plants, or excentric, out of the centre, as in Coffee; in Grasses however it is external. Its direction is either straight, curved, or even spiral, in various instances. The Embryo of seeds that have a single cotyledon, or none at all, is peculiarly simple, without any notch or lobe, and is named by Gærtner *Embryo monocotyledoneus.*

Cotyledones, the Cotyledons, or Seed-lobes, are immediately attached to the Embryo, of which they form, properly speaking, a part. They are commonly two in number, *f.* 7; but in *Pinus*, and *Dombeya*, the Norfolk Island Pine, they are more, *f.* 3, as already mentioned, *p.* 75. When the seed has sufficiently established its root, these generally rise out of the ground, and become a kind of leaves. Such is the true idea of the organs in question, but the same name is commonly given to the body of the seed in the Grass and Corn tribe, the Palms, and several other plants, thence denominated *monocotyledones*, because the supposed *Cotyledon* is single. The nature of this part we shall presently explain. It neither rises out of the ground, nor performs the proper functions of a *Cotyledon*, for what these plants produce is, from the first, a real leaf; or, if the plant has no leaves, the rudiment of a stem, as in *Cuscuta*. In either case, the part produced is solitary, never in pairs; hence Gærtner was misled to reckon *Cyamus Nelumbo, Exot. Bot. t.* 31, 32, among the monocotyledonous plants, the body of its seed remaining in the earth, and the leaves springing one at a time from the Embryo, just as in the Date Palm, Wheat, Barley, &c.

The Seed-lobes of Mosses, according to the observations of Hedwig, *Fund. part* 2. *t.* 6, are above all others numerous and subdivided, *f.* 195, 196, as well as most distinct from the proper leaves; so that these plants are very improperly placed by authors among such as have no Cotyledons, a measure originating probably in theory and analogical reasoning rather than observation.

Albumen, the White, is a farinaceous, fleshy, or horny substance, which makes up the chief bulk of some seeds, as Grasses, Corn, Palms, Lilies, never rising out of the ground nor assuming the office of leaves, being destined solely to nourish the germinating embryo, till its roots can perform their office. In the Date Palm, *f.* 199, *Gærtner*, *t.* 9, this part is nearly as hard as a stone; in *Mirabilis*, *Exot. Bot.* *t.* 23, it is like wheat flour. It is wanting in several tribes of plants, as those with compound, or with cruciform flowers, and the Cucumber or Gourd kind, according to Gærtner. Some few leguminous plants have it, and a great number of others which, like them, have cotyledons besides. We are not however to suppose that so important an organ is altogether wanting, even in the above-mentioned plants. The farinaceous matter, destined to nourish their embryos, is unquestionably lodged in their cotyledons, whose sweet taste as they begin to germinate often evinces its presence, and that it has undergone the same chemical change as in Barley. The *Albumen* of the Nutmeg is remarkable for its eroded variegated appearance, and aromatic quality; the cotyledons of this seed are very small.

Vitellus, the Yolk, first named and fully illustrated by Gærtner, is less general than any of the parts already mentioned. He characterizes it as very firmly and inseparably connected with the Embryo, yet never rising out of the integuments of the seed in germination, but absorbed, like the *Albumen*, for the nourishment of the Embryo. If the *Albumen* be present, the *Vitellus* is always situated between it and the Embryo, and yet is constantly distinct from the former. The *Vitellus* is esteemed by Gærtner to compose the bulk of the seed in *Fuci*, Mosses and Ferns, as well as in the genus *Zamia*, *f.* 200, closely allied to the latter, see his *t.* 3, and even in *Ruppia*, *Engl. Bot. t.* 136, and *Cyamus*. In the natural order of Grasses the part under consideration forms a scale between the *Embryo* and the *Albumen*.

I cannot but think that the *Vitellus* is nothing else than a subterraneous Cotyledon. In the Horse Chesnut and Garden Nasturtium, Gærtner almost allows, see his Introduction, *p.* 151, that they are the same thing. It does not appear that any plant with genuine ascending Cotyledons is likewise furnished with this supposed organ; on the other hand, it is commonly attributed to such as have the most copious *Albumen*, and therefore should seem to answer some other end than mere nutriment, which is supplied by the latter. The reader may consult *Tr. of the Linn. Soc. v.* 9. 204, where this subject is fully discussed. It seems by Decandolle's *Fl. Franc. v.* 1. 157, that Mr. Correa has also exploded the idea of a *Vitellus* in plants, but his reasons do not appear.

We learn from the above inquiries, that the old distinction between plants with one Cotyledon and those with several may still be relied on, though in the former the part which has commonly been so denominated is the *Albumen*, as in Corn, the real Cotyledon of which is the scale or *Vitellus*, which last organ however seems wanting in Palms, Lilies, &c., such having really no Cotyledon at all, nor any thing that can perform its office, except the stalk of their Embryo, which indeed may answer the purpose of a Cotyledon, just as the stems of many plants fulfil the office of leaves. In the Horse Chesnut, Oak and Walnut possibly, whose seed-lobes do not ascend, the functions of a real Cotyledon, as far as air is concerned, and those of the *Albumen* may be united in these lobes, as is the case with most Leguminous plants; which is rendered more probable, as several of the latter have the corresponding parts likewise remaining under ground. Hence the divided "*Vitellus*," as Gærtner terms it, of the *Cyamus* is to be considered as a pair of subterraneous Cotyledons, and the plant consequently ranges near its natural allies the Poppy tribe, as Mr. Salisbury, without the aid of physiology, has shown in the *Annals of Botany*, *v.* 2. *p.* 70, 75.

Testa, *f.* 4, the Skin, contains all the parts of a seed above described, giving them their due shape; for the skin is perfectly formed, while they are but a homogeneous liquid. This coat differs in thickness and texture in different plants. It is sometimes single, but more frequently lined with a finer and very delicate film, called by Gærtner *Membrana*, as may be seen in a Walnut, and the kernel of a Peach, Almond, or Plum. In the Jasmine a quantity of pulp is lodged between the *Membrana* and the *Testa*, constituting a pulpy seed, *semen baccatum*, which is distinct from the *Acinus*, or grain of a compound berry in the Raspberry, the seed of the latter having its proper double covering within the pulp. The *Testa* bursts irregularly, and only from the swelling of its contents in germination.

Hilum, the Scar, is the point by which the seed is attached to its seed-vessel or receptacle, and through which alone life and nourishment are conveyed for the perfecting its internal parts. Consequently all those parts must be intimately connected with the inner surface of this scar, and they are all found to meet there, and to divide or divaricate from that point, more or less immediately. In describing the form or various external portions of any seed, the *Hilum* is always to be considered as the base. When the seed is quite ripe, the communication through this channel is interrupted: it separates from the parent plant without injury, a Scar being formed on each. Yet the *Hilum* is so far capable of resuming its former nature, that the moisture of the earth is imbibed through it previous to germination.

There are various accessory parts, or appendages, to seeds, which come under the following denominations.

Pellicula, the Pellicle, called by Gærtner *Epidermis*, closely adheres to the outside of some seeds, so as to conceal the proper colour and surface of their skin, and is either membranous, and often downy, as in *Convolvulus*, or mucilaginous, not perceptible till the seed is moistened, as in *Salvia verbenaca*, *Engl. Bot. t.* 154. Perhaps the covering of the seed in *Chenopodium*, called by Gærtner *Utriculus*, is merely a *Pellicula*.

Arillus, the Tunic, is either a complete or partial covering of a seed, fixed to its base only, and more or less loosely or closely enveloping its other parts. Of this nature is the pulpy orange-coloured coat in *Euonymus*, *Engl. Bot. t.* 362, the beautiful scarlet cup in *Afzelia*, *f.* 203, and the double membranous coat in *Hippophäe*, *t.* 425, which last invests the seed within the pulp of the berry. The outer of these coats only is described by Gærtner, as a peculiar membrane lining the cell of the berry; his "*integumentum duplex*" refers to the *testa*, which I mention only to prevent misapprehension. The Mace which envelops the Nutmeg is a partial *Arillus*, beautifully drawn in Gærtner, *t.* 41. *Narthecium*, *Engl. Bot. t.* 535, has a complete membranous tunic, elongated beyond the seed at each end, as in many of the Orchis tribe; and such seeds, acquiring thence a light and chaffy appearance, have been denominated *scobiformia*, whence Bergius was perhaps led, very unscientifically, to call the seeds of ferns literally *scobs* or sawdust! An elastic pouch-like *Arillus*, serving to project the seeds with considerable force, occurs in *Oxalis*, *t.* 762 and 1726. In the natural order of *Rutaceæ* the same part, shaped also like a pouch lining each cell of the capsule, is very rigid or horny; see *Dictamnus albus*, or Fraxinella, *Gærtn. t.* 69, and *Boronia*, *Tracts on Nat. Hist. t.* 4—7. Besides this coincidence, there are many common points of affinity between these plants and *Oxalis*, concerning colour, flavour, habit, and structure. *Fagonia* and its allies form the connecting link between them, which Gærtner and Jussieu did not overlook. We have pointed out this affinity in *English Botany*, *p.* 762, and it is confirmed by the curious circumstance of Jacquin's *Oxalis rostrata*, *Oxal. t.* 22, having the very appendages to its filaments which make a peculiar part of the character of *Boronia*.

It is not easy to say whether the various, and frequently elaborate, coat of the seed among the rough-leaved plants, *Borago*, *Anchusa*, *Lithospermum*, *Cynoglossum*, *f.* 201, *Engl. Bot. t.* 921, &c., should be esteemed an *Arillus* or a *Testa*; but the latter seems most correct, each seed having only a simple and very thin membranous internal skin besides. Gærtner therefore justly uses the term Nut for the seeds in question. The same may be observed of *Ranunculus*, *Myosurus*, see *Engl. Bot. t.* 435, *Clematis*, *Anemone*, &c., whose external coats are no less various and elaborate; yet such seeds are as truly naked as those of the *Didynamia* class, figured in Gærtner, *t.* 66, each having a double skin and no more, which is one covering less than even the genuine nut of the stone fruit, or of the *Corylus*. In *Geranium*, *Malva*, &c., what has often been called *Arillus*, is rather a kind of Capsule, not only because their seeds have a double or even triple skin, quite unconnected with this outer cover, but because the latter is analogous to other Capsules.

The loose husky covering of the seed in *Carex*, *f.* 202, is surely an *Arillus*. See *Engl. Bot.* also the Rev. Mr. Wood's observations on this genus in Dr. Rees's *Cyclopædia*, and Gærtner, *v.* 1. 13. This seed has besides a double *Testa*, though most of the true Grasses have but one, which in ground Corn constitutes the bran, the husks of the blossom being the chaff.

Pappus, the Seed-down, is restrained by Gærtner to the chaffy, feathery, or bristly crown of many seeds that have no *Pericarpium*, and which originates from a partial calyx, crowning the summit of each of those seeds, and remaining after the flower is fallen. Instances of this are the feathery appendages to the seeds of Dandelion, *Engl. Bot. t.* 510, and Goat's-beard, *t.* 434, in which the part in question is elevated on a footstalk, *f.* 204. In *Carduus*, or rather *Cnicus*, *t.* 974, 975, it is sessile, though still feathery; in real *Carduus*, *t.* 1112 and 973, bristly; but in *Cichorium*, *t.* 539, consists of mere chaffy teeth, more clearly evincing its affinity to a Calyx. In *Scabiosa* it is double. In *Bidens*, *t.* 1113, 1114, the *Pappus* is formed of two, three or four rigid barbed bristles. The use of this organ is evidently to transport seeds to a distance from their native spot, either by resigning them to the power of the wind, or by attaching them to the shaggy coats of animals. In due time the crown separates, and leaves the seed behind it, which happens sooner with the Thistle than most other plants. Hence the vacant down of that genus is frequently seen wafted in light masses over a whole country; which has not escaped the notice of poets.

The same term is used by the generality of botanists for the feathery crown of seeds furnished with a capsule, as *Epilobium*, *t.* 1177, *Asclepias*, *Cynanchum*, &c., *Gærtn.* *t.* 117, as well as for a similar appendage to the base or sides of any seeds, as *Salix*, *Engl. Bot.* *t.* 183, 1403, *Eriophorum*, *t.* 873, &c., neither of which can originate from a Calyx. For the former of these Gærtner adopts the term *Coma*, for the latter *Pubes*, which last also serves for any downiness or wool about the *Testa* of a seed, as in the Cotton plant, and *Blandfordia nobilis*, *Exot. Bot.* t. 4.

Cauda, *f.* 205, a Tail, is an elongated, generally feathery, appendage to some Seeds, formed of the permanent style, as in *Clematis*, *Engl. Bot.* t. 612, *Dryas*, *t.* 451, *Geum*, *t.* 1400.

Rostrum, a Beak, mostly applies to some elongation of a Seed-vessel, originating likewise from the permanent style, as in *Geranium*, *t.* 272, *Helleborus*, *t.* 200, though it is also used for naked seeds, as *Scandix*, *f.* 206, *t.* 1397.

Ala, *f.* 207, a Wing, is a dilated membranous appendage to Seeds, as in *Embothrium*, *Bot. of N. Holl.* t. 7, *Banksia*, *Conchium*, *Bignonia echinata*, *Gærtn.* t. 52, *Rhinanthus*, *Engl. Bot.* t. 657, serving to waft them along in the air. Gærtner wished to confine this term to a membranous expansion of the top or upper edge of a Seed or Seed-vessel, using *margo membranaceus* for one that surrounds the whole, but he has not adhered to it in practice. Capsules are sometimes furnished with one wing, as the Ash, oftener with several, as *Halesia*, *Acer*, *Begonia*, &c. In Seeds the Wing is commonly solitary, except some Umbelliferous plants, as *Thapsia*, *Gærtn.* t. 21.

Seeds are occasionally furnished with Spines, Hooks, Scales, Crested appendages, particularly a little gland-like part near the Scar, sometimes denominated *Strophiolum*, as in *Asarum*, *Gærtn. t.* 14, *Bossiæa*, *Ventenat. Jard. de Cels*, *t.* 7, *Platylobium*, *Bot. of N. Holl. t.* 6, *Ulex*, *Spartium*, &c. In general however smoothness is characteristic of a seed, by which it best makes its way into the soft earth, though sometimes it is barbed, or at least its covering, as in *Stipa*, *Engl. Bot. t.* 1356, that it may not easily be withdrawn again by the powerful feathery appendage of that plant, which, after having by its circumvolutions forced the seed deeper and deeper, breaks off at a joint, and flies away.

The various modes by which seeds are dispersed cannot fail to strike an observing mind with admiration. Who has not listened in a calm and sunny day to the crackling of Furze bushes, caused by the explosion of their little elastic pods; nor watched the down of innumerable seeds floating on the summer breeze, till they are overtaken by a shower, which moistening their wings stops their further flight, and at the same time accomplishes its final purpose, by immediately promoting the germination of each seed in the moist earth? How little are children aware, as they blow away the seeds of Dandelion, or stick Burs in sport upon each other's clothes, that they are fulfilling one of the great ends of Nature! Sometimes the Calyx, beset with hooks, forms the bur, as in *Arctium Lappa*, *Engl. Bot.* *t.* 1228; sometimes hooks encompass the fruit itself, as in *Xanthium*, and some species of *Galium*, particularly *G. Aparine*, *t.* 816. Plants thus furnished are observed by Linnæus to thrive best in a rank manured soil, with which, by being conveyed to the dens of wild animals, they are most likely to meet. The Awns of grasses answer the same end. Pulpy fruits serve quadrupeds and birds as food, while their seeds, often small, hard and indigestible, pass uninjured through the intestines, and are deposited far from their original place of growth, in a condition peculiarly fit for vegetation. Even such seeds as are themselves eaten, like the various sorts of nuts, are hoarded up in the ground and occasionally forgotten, or carried to a distance, and in part only devoured. The ocean itself serves to waft the larger kinds of seeds, from their native soil to far-distant shores.

7. RECEPTACULUM. The Receptacle is the common base or point of connexion of the other parts of fructification. It is not always distinguishable by any particular figure, except in compound flowers constituting the Linnæan class *Syngenesia*, in which it is very remarkable and important. In the Daisy, *f.* 208, *Engl. Bot.* *t.* 424, it is conical; in *Chrysanthemum*, *t.* 601, convex; in others flat, or slightly concave. *Picris*, *t.* 972, has it naked, that is, destitute of any hairs or scales between the florets or

seeds; *Carduus*, *t.* 1112, hairy; *Anthemis*, *t.* 602, scaly; and *Onopordum*, *t.* 977, cellular like a honey-comb, *f.* 209. On this and the seed-down are founded the most solid generic characters of these plants, admirably illustrated by the inimitable Gærtner.

The term Receptacle is sometimes extended by Linnæus to express the base of a flower, or even its internal part between the stamens and pistils, provided there be any thing remarkable in such parts, without reference to the foundation of the whole fructification. It also expresses the part to which the seeds are attached in a seed-vessel, and the common stalk of a spike, or spikelet, in grasses.

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Having thus explained the various organs of fructification, we shall add a few remarks concerning flowers in general, reserving the functions of the Stamens and Pistils, with the Linnæan experiments and inquiries relative to that curious subject, for the next chapter.

A flower furnished with both calyx and corolla is called *flos completus*, a complete flower; when the latter is wanting, *incompletus*; and when the *corolla* is present without the calyx, *nudus*, naked. When the stamens and pistils are both, as usual, in one flower, that flower is called perfect, or united; when they are situated in different flowers of the same species, such I would call separated flowers; that which has the stamens being named the barren flower, as producing no fruit in itself, and that with pistils the fertile one, as bearing the seed. If this separation extends no further than to different situations on the same individual plant, Linnæus calls such flowers *monoici*, monœcious, as confined to one house or dwelling; if the barren and fertile flowers grow from two separate roots, they are said to be *dioici*, diœcious. Some plants have united flowers and separated ones in the same species, either from one, two or three roots, and such are called polygamous, as making a sort of compound household.

A Compound flower consists of numerous florets, *flosculi*, all sessile on a common undivided Receptacle, and enclosed in one contiguous Calyx or *Perianthium*. It is also essential to this kind of flower that the Anthers should be united into a cylinder, to which only the genus *Tussilago* affords one or two exceptions, and *Kuhnia* another; and moreover, that the stamens should be five to each floret, *Sigesbeckia flosculósa* of L'Heritier, *Stirp. Nov. t.* 19, alone having but three. The florets are always monopetalous and superior, each standing on a solitary naked seed, or at least the rudiments of one, though not always perfected. Some Compound flowers consist of very few florets, as *Humea elegans*, *Exot. Bot. t.* 1, *Prenanthes muralis*, *Engl. Bot. t.* 457; others of many, as the Thistle, Daisy, Sunflower, &c. The florets themselves are of two kinds, *ligulati*, ligulate, shaped like a strap or ribband, *f.* 210, with three or five teeth, as in *Tragopogon*, *t.* 434, and the Dandelion; or *tubulosi*, tubular, cylindrical and five-cleft, as in *Carduus*, *t.* 1112, and *Tanacetum*, *t.* 1229. The marginal white florets of the Daisy, *f.* 211, are of the former description, and compose its *radius*, or rays, and its yellow central ones come under the latter denomination, *f.* 212, constituting its *discus*, or disk. The disk of such flowers is most frequently yellow, the rays yellow, white, red, or blue. No instance is known of yellow rays with a white, red, or blue disk.

An Aggregate flower has a common undivided Receptacle, the Anthers all separate and distant, *Jasione* only, *Engl. Bot. t.* 882, having them united at the base, but not into a cylinder, and the florets commonly stand on stalks, each having a single or double partial calyx. Such flowers have rarely any inclination to yellow, but are blue, purple, or white. Instances are found in *Scabiosa*, *t.* 659 and 1311, *Dipsacus*, *t.* 1032 and 877, and the beautiful Cape genus *Protea*.

Such is the true idea of an Aggregate flower, but Linnæus enumerates, under that denomination, seven kinds, his favourite number: these are,

1. The Aggregate flower properly so called, as just mentioned.
2. The Compound flower previously described.
3. The Amentaceous flower, or Catkin, of which we have spoken, *p.* 189.

4. The Glumose, or Chaffy flower, peculiar to the Grasses, see *p.* 191.
5. The Sheathed flower, whose common receptacle springs from a Sheath, as in *Arum.*
6. The Umbellate; and
7. The Cymose flowers, concerning which two last a few observations are necessary.

Linnæus and his friend Artedi thought the great natural umbelliferous order could not be divided into good and distinct genera by the seeds or parts of the flower, without taking into consideration the general and partial involucral leaves, which they therefore chose to consider as a part of the fructification, and defined as a *calyx remote from the flower.* The rays of the umbel, of course, became the subdivisions of a branched receptacle, and the whole umbel was considered as one aggregate flower. It necessarily followed that a Cyme, see *p.* 180, must be considered in the same light; nor did the sagacity of Linnæus overlook the arguments in favour of this hypothesis. Many of the umbelliferous tribe, as *Heracleum, t.* 939, *Caucalis, Coriandrum,* &c., have their marginal flowers dilated, radiant, and more or less inclined to be imperfect or abortive, thus evincing an analogy with real compound flowers like the Sunflower, which analogy is still more striking between *Oenanthe, t.* 363, 347, 348, and the Marigold, *Calendula.* So the cymose plants, as *Viburnum Opulus, t.* 332, bear dilated and abortive marginal flowers, and *Hydrangea hortensis*, *Sm. Ic. Pict. t.* 12, has scarcely any others. *Cornus sanguinea*, *Engl. Bot. t.* 249, has a naked cyme, *C. Suecica*, *t.* 310, an umbel accompanied by coloured bracteas, or, as Linnæus judged, a coloured *involucrum*, proving the close affinity between these two modes of inflorescence.

Notwithstanding all this, I presume to dissent from the above hypothesis, as offering too great violence to Nature, and swerving from that beautiful and philosophical Linnæan principle, of characterizing genera by the fructification alone; a principle which those who are competent to the subject at all, will, I believe, never find to fail. The seeds and flowers of the umbelliferous family are quite sufficient for our purpose, while the involucrum is very precarious and changeable; often deficient, often immoderately luxuriant, in the same genus. In the cymose plants every body knows the real parts of fructification to be abundantly adequate, the involucrum being of small moment; witness that most natural genus *Cornus*. For all these, and other reasons, to particularize which would lead me too far, I have, *p.* 179, reckoned the Umbel and Cyme modes of flowering, and not themselves aggregate flowers.

CHAPTER XX.

OF THE PECULIAR FUNCTIONS OF THE STAMENS AND PISTILS, WITH THE EXPERIMENTS AND OBSERVATIONS OF LINNÆUS AND OTHERS ON THAT SUBJECT.

THE real use of the Stamens of Plants was long a subject of dispute among philosophers, till Linnæus, according to the general opinion at present, explained it beyond a possibility of doubt. Still there are not wanting persons who from time to time start objections, prompted either by a philosophical pursuit of truth, or an ambitious desire of distinguishing themselves in controverting so celebrated a doctrine, as some have written against the circulation of the animal blood. I propose to trace the history of this doctrine, and especially to review the facts and experiments upon which Linnæus founded his opinion, as well as the objections it has had to encounter. It would be endless, and altogether superfluous, to bring forward new facts in its support, nor shall I do so, except where new arguments may render such a measure necessary.

The Stamens and Pistils of flowers have, from the most remote antiquity, been considered as of great importance in perfecting the fruit. The Date Palm, from time immemorial a primary object of cultivation in the more temperate climates of the globe, bears barren and fertile flowers on separate trees. The ancient Greeks soon discovered that in order to have abundant and well-flavoured fruit, it was expedient to plant both trees near together, or to bring the barren blossoms to those which were to bear fruit; and in this chiefly consisted the culture of that valuable plant. Tournefort tells us that without such assistance dates have no kernel, and are not good food. The same has long been practised, and is continued to this very day in the Levant, upon the *Pistacia*, and the Fig.

At the revival of learning botanists were more occupied in determining the species, and investigating the medical properties of plants, than in studying their physiology; and when after a while the subject in question was started, some of them, as Morison, Tournefort and Pontedera, uniformly treated with great contempt the hypothesis which has since been established. We shall, as we proceed, advert to some of their arguments.

About the year 1676, Sir Thomas Millington, Savilian Professor at Oxford, is recorded to have hinted to Dr. Grew that the use of the Stamens was probably to perfect and fertilize the seed. Grew adopted the idea, and the great Ray approved it. Several other botanists either followed them, or had previously conceived the same opinion, among which R. J. Camerarius, Professor at Tubingen towards the end of the seventeenth century, was one of the most able and original. Vaillant wrote an excellent oration on the subject, which being hostile to the opinions of Tournefort, lay in obscurity till published by Boerhaave. Blair and Bradley assented in England, and several continental botanists imbibed the same sentiments. Pontedera, however, at Padua, an university long famous, but then on the decline, and consequently adverse to all new inquiry and information, in 1720 published his *Anthologia*, quite on the other side of the question.

Linnæus, towards the year 1732, reviewed all that had been done before him, and clearly established the fact so long in dispute, in his *Fundamenta* and *Philosophia Botanica*. He determined the functions of the Stamens and Pistils, proved these organs to be essential to every plant, and thence conceived the happy idea of using them for the purpose of systematical arrangement. In the latter point his merit was altogether original; in the former he made use of the discoveries and remarks of others, but set them in so new and clear a light, as in a manner to render them his own.

We have already mentioned, *p.* 106, the two modes by which plants are multiplied, and have shown the important difference between them. Propagation by seed is the only genuine reproduction of the species, and it now remains to prove that the essential organs of the flower are indispensably requisite for the perfecting of the seed.

Every one must have observed that the flower of a plant always precedes its fruit. To this the Meadow Saffron, *Engl. Bot. t.* 133, seems an objection, the fruit and leaves being perfected in the spring, the blossoms not appearing till autumn; but a due examination will readily ascertain that the seed-bud formed in autumn is the very same which comes to maturity in the following spring. A Pine-apple was once very unexpectedly cited to me as an instance of fruit being formed before the flower, because the green fruit in that instance, as in many others, is almost fully grown before the flowers expand. The seeds however, the essence of the fruit, are only in embryo at this period, just as in the germen of an Apple blossom.

It was very soon ascertained that flowers are invariably furnished with Stamens and Pistils, either in the same individual, or two of the same species, however defective they may be in other parts; of which *Hippuris*, *Engl. Bot. t.* 763, the most simple of blossoms, is a remarkable example. Few botanists indeed had detected them in the *Lemna* or Duck-weed, so abundant on the surface of still waters, and Valisneri alone for a long time engrossed the honour of having seen them. In our days however they rewarded the researches of the indefatigable Ehrhart in Germany, and, on being sought with equal acuteness, were found in England. Three species have been delineated in *Engl. Bot. t.* 926, 1095 and 1233, from the discoveries of Mr. Turner and Mr. W. Borrer. The flowers of Mosses, long neglected and afterwards mistaken, were faithfully delineated by Micheli, carefully examined and properly understood by Linnæus as he rambled over the wilds of Lapland*, and at length fully illustrated, and placed out of all uncertainty, by the justly celebrated Hedwig. These parts indeed are still unknown in ferns, or at least no satisfactory explanation of them has reached me, though the seeds and seed-vessels are sufficiently obvious.

The existence of the parts under consideration is so incontrovertible in every flower around us, that Pontedera was reduced to seek plants without stamens among the figures of the *Hortus Malabaricus*; but the plates in which he confided are now known to be faulty in that very particular.

Plants indeed have occasionally abortive stamens in one flower and barren pistils in another, and the Plantain-tree, *Musa*, is described by Linnæus as having five out of its six stamens perfected in such blossoms as ripen no fruit, while those with a fertile germen contain only a single ripe stamen, five being ineffective. This only shows the resources, the wisdom, and the infinite variety of the creation. When the roots are luxuriantly prolific, the flowers are in some measure defective, Nature, relaxing as it were from her usual solicitude, and allowing her children to repose, and indulge in the abundance of good things about them. But when want threatens, she instantly takes the alarm;

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* This hitherto unknown fact appears in his Tour through that country, lately published in English, v. 1. 185.

all her energies are exerted to secure the future progeny, even at the hazard of the parent stock, and to send them abroad to colonise more favourable situations.

Most generally the access of the pollen is not trusted to any accidental modes of conveyance, however numerous, elaborate, and, if we may so express it, ingenious, such modes may be; but the Stamens are for greater security lodged in the same flower, under the protection of the same silken veils, or of more substantial guards, which shelter their appropriate pistils. This is the case with the majority of our herbs and shrubs, and even with the trees of hot countries, whose leaves being always present might impede the passage of the pollen. On the contrary, the trees of cold climates have generally separated flowers, blossoming before the leaves come forth, and in a windy season of the year; while those which blossom later, as the Oak, are either peculiarly frequented by insects, or, like the numerous kinds of Fir, have leaves so little in the way, and pollen so excessively abundant, that impregnation can scarcely fail.

The pollen and the stigma are always in perfection at the same time, the latter commonly withering and falling off a little after the anthers, though the style may remain, to become an useful appendage to the fruit. The *Viola tricolor* or Pansy, the *Gratiola*, the *Martynia*, and many plants besides, have been observed to be furnished with a stigma gaping only at the time the pollen is ripe. The beautiful Jacobæan Lily, *Amaryllis formosissima*, *Curt. Mag. t.* 47, is justly described by Linnæus as provided with a drop of clear liquid, which protrudes every morning from the stigma, and about noon seems almost ready to fall to the ground. It is however reabsorbed in the afternoon, having received the pollen whose vapour renders it turbid, and whose minute husks afterwards remain upon the stigma. The same phænomenon takes place several successive days.

In opposition to similar facts, proving the synchronous operation of these organs, Pontedera has, with more observation than usual, remarked that in the umbelliferous tribe the style frequently does not appear till the anthers are fallen. But he ought to have perceived that the stigma is previously perfected, and that the style grows out afterwards, in a recurved and divaricated form, for the purpose of providing hooks to the seeds. It is also observable that in this family the several organs are sometimes brought to perfection in different flowers at different times, so that the anthers of one may impregnate the stigmas of another whose stamens were abortive, or long since withered. The same thing happens in other instances. Linnæus mentions the *Jatropha urens* as producing flowers with stamens some weeks in general before or after the others. Hence he obtained no seed, till he preserved the pollen for a month or more in paper, and scattered it on a few stigmas then in perfection. There can be no doubt that, in a wild state, some or other of the two kinds of blossoms are ripe together, throughout the flowering season, on different trees.

A similar experiment to that just mentioned was made in 1749 upon a Palm-tree at Berlin, which for want of pollen had never brought any fruit to perfection. A branch of barren flowers was sent by the post from Leipsic, twenty German miles distant, and suspended over the pistils. Consequently abundance of fruit was ripened, and many young plants raised from the seeds*.

Tournefort and Pontedera supposed the pollen to be of an excrementitious nature, and thrown off as superfluous. But its being so curiously and distinctly organized in every plant, and producing a peculiar vapour on the accession of moisture, shows, beyond contradiction, that it has functions to perform after it has left the anther. The same writers conceived that the stamens might possibly secrete something to circulate from them to the young seeds; an hypothesis totally subverted by every flower with separated organs, whose stamens could circulate nothing to germens on a different branch or root; a difficulty which the judicious Tournefort perceived, and was candid enough to allow.

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* What species of Palm was the subject of this experiment does not clearly appear. In the original communication to Dr. Watson, printed in the preface of Lee's *Introduction to Botany*, it is called *Palma major foliis flabelliformibus*, which seems appropriate to *Rhapis flabelliformis*, *Ait. Hort. Kew.* v. 3. 473; yet Linnæus, in his Dissertation on this subject, expressly calls it *Phœnix dactylifera*, the Date Palm, and says he had in his garden many vigorous plants raised from a portion of the seeds above mentioned. The great success of the experiment, and the "fan-shaped" leaves, make me rather take it for the *Rhapis*, a plant not well known to Linnæus.

Both the conjectures just mentioned vanish before one luminous experiment of Linnæus, of all others the most easy to repeat and to understand. He removed the anthers from a flower of *Glaucium phœniceum*, *Engl. Bot. t.* 1433, stripping off the rest of that day's blossoms. Another morning he repeated the same practice, only sprinkling the stigma of that blossom, which he had last deprived of its own stamens, with the pollen from another. The flower first mutilated produced no fruit, but the second afforded very perfect seed. "My design," says Linnæus, "was to prevent any one in future from believing that the removal of the anthers from a flower was in itself capable of rendering the germen abortive."

The usual proportion and situation of stamens with respect to pistils is well worthy of notice. The former are generally shortest in drooping flowers, longest in erect ones. The barren blossoms stand above the fertile-ones in *Carex*, *Coix*, *Arum*, &c., that the pollen may fall on the stigmas. This is the more remarkable, as the usual order of Nature seems in such plants, as well indeed as in compound, and even umbelliferous flowers, to be reversed, for the pistils are invariably central, or internal, in every simple flower, and would therefore, if drawn out into a monœcious spike, be above the stamens.

Many curious contrivances of Nature serve to bring the anthers and stigmas together. In *Gloriosa*, *Andr. Repos. t.* 129, the style is bent, at a right angle from the very base, for this evident purpose. In *Saxifraga*, and *Parnassia*, *Engl. Bot. t.* 82, the stamens lean one or two at a time over the stigma, retiring after they have shed their pollen, and giving place to others; which wonderful œconomy is very striking in the garden Rue, *Ruta graveolens*, whose stout and firm filaments cannot be disturbed from the posture in which they may happen to be, and evince a spontaneous movement unaffected by external causes. The five filaments of the *Celosia*, Cock's-comb, are connected at their lower part by a membranous web, which in moist weather is relaxed, and the stamens spread for shelter under the concave lobes of the corolla. When the air is dry the contraction of the membrane brings them together, to scatter their pollen in the centre of the flower. The elastic filaments of *Parietaria*, *Engl. Bot. t.* 879, for a while restrained by the calyx, as those of the lovely *Kalmiæ*, *Curt. Mag. t.* 175, 177, are by the minute pouches in the corolla, relieve themselves by an elastic spring, which in both instances serves to dash the pollen with great force upon the stigma. The same end is accomplished by the curved germen of *Medicago falcata*, *Engl. Bot. t.* 1016, releasing itself by a spring from the closed keel of the flower.

But of all flowers that of the Barberry-bush, *t.* 49, is most worthy the attention of a curious physiologist. In this the six stamens, spreading moderately, are sheltered under the concave tips of the petals, till some extraneous body, as the feet or trunk of an insect in search of honey, touches the inner part of each filament near the bottom. The irritability of that part is such, that the filament immediately contracts there, and consequently strikes its anther, full of pollen, against the stigma. Any other part of the filament may be touched without this effect, provided no concussion be given to the whole. After a while the filament retires gradually, and may again be stimulated; and when each petal, with its annexed filament, is fallen to the ground, the latter on being touched shows as much sensibility as ever. See *Tracts on Nat. History*, 165. I have never detected any sympathy between the filaments, nor is any thing of the kind expressed in the paper just mentioned, though Dr. Darwin, from some unaccountable misapprehension, has quoted me to that effect. It is still more wonderful that the celebrated Bonnet, as mentioned in Senebier's *Physiologie Végétale*, *v.* 5. 105, should have observed this phænomenon in the Barberry so very inaccurately as to compare it to the relaxation of a spring, and that the ingenious Senebier himself, in quoting me, *p.* 108, for having ascertained the lower part only of each filament to be irritable, should express himself as follows: "It has not yet been proved that the movement of the stamens is attended with the contraction of the filaments; which nevertheless was the first proof necessary to have been given in order to ascertain their irritability; it is not even yet well known which is the irritable part of the filaments, and whether it be only their base, as Smith has had the address to discover." In answer to which I need only request any one to read the above account, or the more ample detail in my original paper, and above all, to examine a Barberry-blossom for himself; and if any doubts remain concerning the existence of vegetable irritability, let him read Senebier's whole chapter intended to disprove it, where that candid philosopher, while he expresses his own doubts, has brought together every thing in its favour. Among the whole of his facts nothing is more decisive than the remarks of Coulomb and Van Marum on the *Euphorbia*, whose milky juices flow so copiously from a wound, in consequence of the evident irritability of their vessels; but when the life of the plant is destroyed by electricity, all the flowing is at an end. It is superfluous to add any thing on this subject, and I return to that of the impregnation of flowers.

I have already mentioned that any moisture causes the pollen to explode, consequently its purpose is liable to be frustrated by rain or heavy dews. Linnæus observes that husbandmen find their crops of rye to suffer more from this cause than barley, because in the latter the anthers are more protected by the husks; and the Juniper berries are sparingly, or not at all, produced in Sweden when the flowering season has been wet. The same great observer also remarks, what yearly experience confirms, that Cherry-trees are more certainly fruitful than Pear-trees, because in the former the opening of the anthers is, in each blossom, much more progressive, so that a longer period elapses for the accomplishment of the fertilization of the germen, and there is consequently less chance of its being hindered by a few showers.

To guard against the hurtful influence of nocturnal dews or drenching rains, most flowers either fold their petals together, or hang down their heads, when the sun does not shine; by which, their internal organs are sheltered. In some which always droop, as the Snowdrops *Galanthus* and *Leucojum*, *Engl. Bot. t.* 19 and 621, the Fritillary, *t.* 622, the Crown Imperial, various species of *Campanula*, and others, while the overshadowing corolla keeps off rain, the air has free access underneath to blow the pollen to the stigma. Nor is this drooping caused by the weight of the flowers, for the fruit in most of them is much heavier, and yet stands erect on the very same stalk. The papilionaceous flowers in general spread their wings in fine weather, admitting the sun and air to the parts within; whereas many of them not only close their petals at night, but also derive additional protection from the green leaves of the plant folding closely about them. *Convolvulus arvensis, t.* 312, *Anagallis arvensis, t.* 529, *Calendula pluvialis*, and many others, are well known to shut up their flowers against the approach of rain; whence the *Anagallis* has been called the Poor Man's Weather-glass. It has been observed by Linnæus that flowers lose this fine sensibility, either after the anthers have performed their office, or when deprived of them artificially; nor do I doubt the fact. I have had reason to think that, during a long continuance of wet, the sensibility of the *Anagallis* is sometimes exhausted; and it is evident that very sudden thunder-showers often take such flowers by surprise, the previous state of the atmosphere not having been such as to give them due warning.

That parts of vegetables not only lose their irritability, but even their vital principle, in consequence of having accomplished the ends of their being, appears from an experiment of Linnæus upon Hemp. This is a diœcious plant, see *p.* 234, and Linnæus kept several fertile-flowered individuals in separate apartments from the barren ones, in order to try whether they could perfect their seeds without the aid of pollen. Some few however remained with the barren-flowered plants, and these ripened seed in due time, their stigmas having faded and withered soon after they had received the pollen. On the contrary, the stigmas which had been out of its reach continued green and vigorous, as if in vain expectation, nor did they begin to fade till they had thus lasted for a very long while. Since I read the history of this experiment, I have found it easy in many plants to tell by the appearance of the stigma whether the seed be fertilized or not. The above experiment is the more important, as the abbé Spallanzani has recorded one made by himself upon the same species of plant, with a contrary result. But as he has said nothing of the appearance of the stigmas, his experiment must yield to that of Linnæus in point of accuracy; and even if his account be otherwise correct, the result is easily explained. Hemp, Spinach, some Nettles, &c., naturally diœcious, are occasionally not completely so, a few latent barren or fertile flowers being frequently found among those of the other sort, by which provision is made against accidents, and the perfecting of a few seeds, at any rate, secured.

In general, germens whose stigmas have not received the pollen wither away without swelling at all; but some grow to a considerable size, and in such the substance of the seed, its skin, and even its cotyledons, are often to be found, the embryo only being wanting. In a Melon or Cucumber it is common to find, among numerous perfect seeds, many mere unimpregnated husks. In the magnificent *Cycas revoluta* which bore fruit at the bishop of Winchester's, and of which a history with plates is given in the sixth volume of the Linnæan Society's Transactions, I found the *drupa* and all its contents apparently perfect, except that there was only a minute cavity where the embryo should have been, in consequence of the want of another tree with stamens, which was not to be found perhaps nearer than Japan. Gardeners formerly attempted to assist Nature by stripping off the barren flowers of Melons and Cucumbers, which, having no germen, they found could not come to fruit, and were therefore, as they supposed, an unnecessary encumbrance to the constitution of the parent plant. But finding that, by such a practice, they obtained no fruit at all, they soon learned the wiser method of admitting air as often as possible to the flowering plants, for the purpose of blowing the pollen from one blossom to the other, and even to gather the barren kind, and place it over that destined to bear fruit.

The œconomy of various aquatic plants throws great light upon the subject before us. Different species of *Potamogeton*, *Engl. Bot. t.* 168, 297, 376, &c., *Ruppia maritima*, *t.* 136, and others, float entirely under water, often at some considerable depth, till the flowering season arrives, when they rise near the surface, and throw up their flowering spikes above it, sinking afterwards to ripen and sow their seeds at the bottom. *Nymphæa alba*, *t.* 160, is very truly described by Linnæus in his *Flora Suecica*, as closing its flowers in the afternoon and laying them down upon the surface of the water till morning, when it raises and expands them, often, in a bright day, to several inches above the water. To this I can speak from my own knowledge, and it is confirmed by the history given by Theophrastus of his *Lotus*, which, according to all appearance, is the *Nymphæa Lotus* of Linnæus. "This," says he, "as well as the *Cyamus**, bears its fruit in a head. The flower is white, consisting of many crowded leaves about as broad as those of a lily. These leaves at sunset fold themselves together, covering the head (or seed-vessel). At sun-rise they expand, and rise above the water. This they continue till the head is perfected, and the flowers fall off." So far Theophrastus writes as of his own knowledge; he continues as follows: "It is reported that in the Euphrates the head and flowers keep sinking till midnight, when they are so deep in the water as to be out of reach of the hand, but towards morning they return, and still more as the day advances. At sunrise they are already above the surface, with the flower expanded; afterwards they rise high above the water." Pliny repeats the same account; and Prosper Alpinus, whose purpose is to prove the *Lotus* of Theophrastus not different from the common *Nymphæa*, in which, as far as *genus* is concerned, he is correct, has the following remarkable passage: "The celebrated stories of the *Lotus* turning to the sun, closing its flowers and sinking under water at night, and rising again in the morning, are conformable to what every body has observed in the *Nymphæa*."

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* *Exot. Bot. t.* 31, 32.

I have been the more particular in the above quotations, because the veracity of Theophrastus has lately been somewhat rudely impeached, on very questionable authority. For my own part, I think what we see of the *Nymphæa* in England is sufficient to render the above account highly probable in a country where the sun has so much more power, even if it did not come from the most faithful and philosophical botanist of antiquity, and I have always with confidence cited it on his authority. The reader, however, will perceive that the only important circumstance for our purpose is the closing of the flowers at night, which is sufficiently well established.

But the most memorable of aquatic plants is the *Valisneria spiralis*, well figured and described by Micheli, *Nov. Gen. t.* 10, which grows at the bottoms of ditches in Italy. In this the fertile flowers stand on long spiral stalks, and these by uncoiling elevate them to the surface of the water, where the calyx expands in the open air. In the mean while plenty of barren flowers are produced on a distinct root, on short straight stalks, from which they rise like little separate white bubbles, suddenly expanding when they reach the surface, and floating about in such abundance as to cover it entirely. Thus their pollen is scattered over the stigmas of the first-mentioned blossoms, whose stalks soon afterwards resume their spiral figure, and the fruit comes to maturity at the bottom of the water. All this Micheli has described, without being aware of its final purpose; so different is it to observe and to reason!

Some aquatic vegetables, which blossom under water, seem to have a peculiar kind of glutinous pollen, destined to perform its office in that situation, as *Chara*, *Engl. Bot. t.* 336, &c.; as well as the *Fucus* and *Conferva* tribe; but of the real nature of the fructification of these last we can at present only form analogical conjectures.

The fertilization of the Fig is accomplished in a striking manner by insects, as is that of the real Sycamore, *Ficus Sycomorus.* In this genus the green fruit is a hollow common calyx, or rather receptacle, lined with various flowers, seldom both barren and fertile in the same fig. This receptacle has only a very small orifice at the summit. The seeds therefore would not in general be perfected, were it not for certain minute flies of the genus *Cynips*, continually fluttering from one fig to the other all covered with pollen, and depositing their eggs within the cavity.

A very curious observation is recorded by Schreber and Willdenow concerning the *Aristolochia Clematitis*, *Engl. Bot. t.* 398. The stamens and pistils of this flower are enclosed in its globular base, the anthers being under the stigma, and by no means commodiously situated for conveying their pollen to it. This therefore is accomplished by an insect, the *Tipula pennicornis*, which enters the flower by the tubular part. But that part being thickly lined with inflexed hairs, though the fly enters easily, its return is totally impeded, till the corolla fades, when the hairs lie flat against the sides, and allow the captive to escape. In the mean while the insect, continually struggling for liberty, and pacing his prison round and round, has brushed the pollen about the stigma. I do not doubt the accuracy of this account, though I have never caught the imprisoned *Tipula* *. Indeed I have never seen any fruit formed by this plant. Probably for want of some insect adapted to the same purpose in its own country, the American *Aristolochia Sipho*, though it flowers plentifully, rarely forms fruit in our gardens. That it sometimes does, I have been informed by the late Lady Amelia Hume, since the first edition of this work was published.

The ways in which insects serve the same purpose are innumerable. These active little beings are peculiarly busy about flowers in bright sunny weather, when every blossom is expanded, the pollen in perfection, and all the powers of vegetation in their greatest vigour. Then we see the rough sides and legs of the bee, laden with the golden dust, which it shakes off, and collects anew, in its visits to the honeyed stores inviting it on every side. All Nature is then alive, and a thousand wise ends are accomplished by innumerable means that "seeing we perceive not;" for though in the abundance of creation there seems to be a waste, yet in proportion as we understand the subject, we find the more reason to conclude that nothing is made in vain.

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* Dr. Lamb of Newberry has lately sent me specimens of the flowers, with the insect enclosed, from the Oxford garden, where they were discovered by a young gardener.—*August* 1813.

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CHAPTER XXI.

ON THE DISEASES OF PLANTS, PARTICULARLY AS ILLUSTRATIVE OF THEIR VITAL PRINCIPLE.

THE diseases of Vegetables serve in many instances to prove their vitality, and to illustrate the nature of their constitution.

Plants are subject to Gangrene or *Sphacelus*, especially the more succulent kinds, of which a very curious account, concerning the *Cactus coccinellifer*, Indian Fig, or Nopal, extremely to our present purpose, is given by M. Thiery de Menonville, in his work on the culture of the Nopal as the food of the Cochineal insect. This writer travelled, about 30 years since, through the Spanish settlements in South America, chiefly noted for the cultivation of this precious insect, on purpose to transport it clandestinely to some of the French islands. Such were the supineness and ignorance of the Spaniards, that he succeeded in conveying, not only the living insects, but the bulky plant necessary for their sustenance, notwithstanding severe edicts to the contrary. He had attended previously to the management of the Nopal, and made his remarks on the diseases to which it is liable. Of these the Gangrene is extremely frequent in the true Nopal of Mexico, beginning by a black spot, which spreads till the whole leaf or branch rots off, or the shrub dies. But the same kind of plant is often affected with a much more serious disease, called by Thiery "*la dissolution.*" This seems to be a sudden decay of the vital principle, like that produced in animals by lightning or strong electricity. In an hour's time, from some unknown cause, a joint, a whole branch, or sometimes an entire plant of the Nopal, changes from apparent health to a state of putrefaction or dissolution. One minute its surface is verdant and shining; the next it turns yellow, and all its brilliancy is gone. On cutting into its substance, the inside is found to have lost all cohesion, being quite rotten. The only remedy in this case is speedy amputation below the diseased part. Sometimes the force of the vital principle makes a stand, as it were, against the encroaching disease, and throws off the infected joint or branch. Such is the account given by Thiery, which evinces a power in vegetables precisely adequate to that of the animal constitution, by which an injured or diseased part is, by an effort of Nature, thrown off to preserve the rest.

Nor need we travel to Mexico to find examples of this. Every deciduous tree or shrub exhibits the very same phænomenon; for the fall of their decaying foliage in autumn, leaving the branches and young buds vigorous and healthy, can be explained in no other way. Yet Du Hamel laboured in vain to account for the fall of the leaf*; nor is it wonderful that he or any body else, who endeavours to explain the physiology of vegetables or of animals according to one principle only, whether it be mechanical or chemical, should entirely fail. To consider the fall of leaves in autumn as a sloughing, or casting off diseased or worn out parts, seems so simple and evident, as to be hardly worth insisting upon. Yet I find myself anticipated in this theory by one physiologist only, named Vrolick, cited by Willdenow, in his *Principles of Botany*, *p*. 304, though several learned speculations to no purpose are extant on the subject. It is but just, however, that I should relate what led me to consider the matter with any attention. My observing friend Mr. Fairbairn of Chelsea garden long ago remarked to me, that when he had occasion to transplant any tree or shrub whilst in leaf, he could soon judge of its success by the ease with which its leaves were detached. The consequence of such treatment is more or less injury to the health of the plant, as will first appear by the drooping of the leaves, most of which will probably die, and the decay will generally be extended to the younger more delicate twigs. The exact progress of this decay may speedily be known, by the leaves of those branches which are irrecoverably dying or dead, remaining firmly attached, so as not to be pulled off without a force sufficient to bring away the bark or buds along with them: whereas the leaves of parts that have received no material injury, and where the vital energy acts with due power, either fall off spontaneously or are detached by the slightest touch. Plants of hot countries, kept in our stoves, exhibit the same phænomenon when transplanted or otherwise injured, even though not naturally deciduous.

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* See his *Phys. des Arbres*, v. 1. 227.

So when fruits are thoroughly ripened, they become, with respect to the parent plant, dead substances, and, however strongly attached before, are then thrown off as extraneous bodies. Their stalks fade or wither, though the life of the adjoining branch continues unimpaired, and a line of separation is soon drawn. In a poor soil, or unfavourable climate, a bunch or spike which should naturally consist of a considerable number of flowers, bears perhaps not half so many. Its upper part very early withers, the vital principle ceases to act at the point beyond which it could not continue to act with effect, and all its energy is directed to perfect what lies within the compass of its resources. This is evident in *Lathyrus odoratus*, the Sweet Pea of our gardens, a native of a very hot climate, at the summits of whose flower-stalks are generally found the rudiments of one or more flowers, not attempted to be perfected. So also the first Barley sown on the sandy heaths of Norfolk, and indeed too many a following crop, bears very few grains in an ear; for the same meagre supply of nourishment, bestowed equally on a numerous spike of blossoms, would infallibly starve them all. In like manner one seed only is perfected in the best wild Arabian Coffee, known by its round form; while the West Indian plantation Coffee has two in each berry, both consequently flattened on one side. The former grows in barren open places, in situations sufficiently favourable for the impregnation of its blossoms, but far less so for the perfecting of much seed; while the latter, well supplied with manure and moisture, is enabled to bring every germ to maturity.

Very strange effects are often produced upon plants by the attacks of insects, whence the various kinds of Galls derive their origin. These are occasioned by the punctures of those little animals, chiefly of the *Hymenoptera* order, and of the genus *Cynips*, in some vigorous part of the plant, as the leaves, leaf-stalks, young stem or branches, and sometimes the calyx or germen. The parent insect deposits its egg there, which is soon hatched; and in consequence of the perpetual irritation occasioned by the young maggot, feeding on the juices of the plant, the part where it is lodged acquires a morbid degree of luxuriance, frequently swelling to an immoderate size, and assuming the most extraordinary and whimsical shapes. This often happens to the shrubby species of Hawkweed, *Hieracium sabaudum*, *Engl. Bot. t.* 349, and *umbellatum*, *t.* 1771, whose stems in consequence swell into oval knots. Several different kinds of Galls are borne by the Oak, as those light spongy bodies, as big as walnuts, vulgarly named Oak apples; a red juicy berry-like excrescence on its leaves; and the very astringent Galls brought from the Levant, for the purposes of dyeing and making ink, which last are produced by a different species of *Quercus* from either of our own. The common Dog-rose, *t.* 992, frequently bears large moss-like balls, in whose internal parts numerous maggots are always to be found, till they become the winged *Cynips Rosæ*, and eat their way out. Many of our Willows bear round excrescences, as large as peas, on their leaves; but I remember to have been very much astonished in Provence with a fine branched production on the Willows in winter, which appeared like a tufted *Lichen*, but proved on examination a real Gall. Indeed our *Salix Helix*, *t.* 1343, is called Rose Willow from its bearing no less remarkable an excrescence, like a rose, at the ends of some of its branches, in consequence of the puncture of an insect; and these are in like manner durable, though the proper leaves fall. The Mastic-tree, *Pistacia Lentiscus*, is often laden, in the south of Europe, with large red hollow finger-like bodies, swarming internally with small insects, the *Aphis Pistaciæ* of Linnæus. The young shoots of *Salvia pomifera*, *Fl. Græc. t.* 15, *S. triloba*, *t.* 17, and even *S. officinalis*, in consequence of the attacks probably of some *Cynips*, swell into large juicy balls, very like apples, and even crowned with rudiments of leaves resembling the calyx of that fruit. These are esteemed in the Levant for their aromatic and acid flavour, especially when prepared with sugar.

It may be remarked that all the excrescences above mentioned are generally more acid than the rest of the plant that bears them, and also greatly inclined to turn red. The acid they contain is partly acetous, but more of the astringent kind.

The diseases of the skin, to which many vegetables are subject, are less easily understood than the foregoing. Besides one kind of Honey-dew, already mentioned, *p.* 144, something like leprosy may be observed in *Tragopogon major*, *Jacq. Austr. t.* 29, which, as I have been informed by an accurate observer, does not injure the seed, nor infect the progeny. The stem of Shepherd's Purse, *Engl. Bot. t.* 1485, is occasionally swelled, and a white cream-like crust, afterwards powdery, ensues. The White Garden Rose, *Rosa alba*, produces, in like manner, an orange-coloured powder. It proves very difficult, in many cases, to judge whether such appearances proceed from a primary disease in the plant, arising from unseasonable cold or wet, or are owing to the baneful stimulus of parasitical *fungi* irritating the vital principle, like the young progeny of insects as above related. Sir Joseph Banks has, with great care and sagacity, traced the progress of the Blight in Corn, *Uredo frumenti*, *Sowerb. Fung. t.* 140, and given a complete history of the minute fungus which causes that appearance. See *Annals of Botany*, *v.* 2. 51, *t.* 3, 4. Under the inspection of this eminent promoter of science, Mr. Francis Bauer has made microscopical drawings of many similar *fungi* infecting the herbage and seeds of several plants, but has decided that the black swelling of the seed of corn, called by the French *Ergot*, though not well distinguished from other appearances by the generality of our agricultural writers, is indubitably a morbid swelling of the seed, and not in any way connected with the growth of a fungus. The anthers of certain plants often exhibit a similar disease, swelling, and producing an inordinate quantity of dark purplish powder instead of true pollen, as happens in *Silene inflata*, *Fl. Brit. Engl. Bot. t.* 164, and the white *Lychnis dioica*, *t.* 1580, whose petals are, not uncommonly, stained all over with this powder. Our knowledge on all these subjects is yet in its infancy; but it is to be hoped, now the pursuit of agriculture and of philosophical botany begin to be, in some distinguished instances, united, such examples will be followed, and science directed to one of its best ends, that of improving useful arts. And here I cannot but mention the experiments continually going on under the inspection of the ingenious Mr. Knight, of fertilizing the germen of one species or variety with the pollen of another nearly akin, as in apples, garden peas, &c., by which, judiciously managed, the advantages of different kinds are combined. By the same means Linnæus obtained intermediate species or varieties of several plants; and if any thing were wanting to confirm his theory respecting the stamens and pistils, this alone would place it out of all uncertainty.

CHAPTER XXII.

OF THE SYSTEMATICAL ARRANGEMENT OF PLANTS. NATURAL AND ARTIFICIAL METHODS. GENERA, SPECIES, AND VARIETIES. NOMENCLATURE.

THE foregoing chapters have sufficiently explained the parts of plants, and the leading differences in their conformation, for us now to proceed to the Systematical part of our subject. In this, when properly understood and studied, there is no less exercise for the mind, no less employment for its observation and admiration, than in physiological or anatomical inquiries; nor are the organs of vegetables, when considered only as instruments of classification and discrimination, less conspicuous for beauty, fitness, and infinite variety of contrivance, than under any other point of view. The wisdom of an Infinite Superintending Mind is displayed throughout Nature, in whatever way we contemplate her productions.

When we take into consideration the multitude of species which compose the vegetable kingdom, even in any one country or climate, it is obvious that some arrangement, some regular mode of naming and distinguishing them, must be very desirable, and even necessary, for retaining them in our own memory, or for communicating to others any thing concerning them. Yet the ancients have scarcely used any further classification of plants than the vague and superficial division into trees, shrubs and herbs, except a consideration of their places of growth, and also of their qualities. The earlier botanists among the moderns almost inevitably fell into some rude arrangement of the objects of their study, and distributed them under the heads of Grasses, Bulbous plants, Medicinal or Eatable plants, &c., in which their successors made several improvements, but it is not worth while to contemplate them.

The science of Botanical Arrangement first assumed a regular form under the auspices of Conrad Gesner and Cæsalpinus, who, independent of each other, without any mutual communication, both conceived the idea of a regular classification of plants, by means of the parts of fructification alone, to which the very existence of Botany as a science is owing. The first of these has left us scattered hints only, in various letters, communicated to the world after his premature death in 1565: the latter published a system, founded on the fruit, except the primary division into trees and herbs, in a quarto volume printed at Florence in 1583. This work Linnæus studied with great care, as appears from the many notes and marked passages in his own copy now before me. Hence he adopted his ideas of the supposed origin of the calyx, corolla, stamens, and pistils, from the outer bark, inner bark, wood and pith, which are now proved to be erroneous. In his own

Classes Plantarum he has drawn out a regular plan of the System of Cæsalpinus, the chief principles of which are the following:

1. Whether the embryo be at the summit or base of the seed.
2. Whether the germen be superior or inferior.
3. Seeds 1, 2, 3, 4, or numerous.
4. Seed-vessels 1, 2, 3, 4, &c.

The work of Cæsalpinus, though full of information, was too deep to be of common use, and excited but little attention. A century afterwards Morison, Professor of Botany at Oxford, improved somewhat upon the ideas of the last-mentioned writer, but has been justly blamed for passing over in silence the source of his own information. Ray, the great English naturalist, formed a considerably different system upon the fruit, as did Hermann, Professor at Leyden, and the great Boerhaave; but in these last there is little originality.

Rivinus, Ruppius and Ludwig in Germany proposed to arrange plants by the various forms of their Corolla, as did Tournefort the illustrious French botanist, whose system is by far the best of the kind; and this having been more celebrated than most others, I shall give a sketch of its plan.

In the first place we meet with the old but highly unphilosophical division into Herbs and Trees, each of which sections is subdivided into those with a Corolla and those without. The Trees with a Corolla are again distributed into such as have one or many petals, and those regular or irregular.—Herbs with a Corolla have that part either compound (as the Dandelion, Thistle and Daisy), or simple; the latter being either of one or many petals, and in either case regular or irregular. We come at last to the final sections, or classes, of the Tournefortian system. Herbs with a simple, monopetalous, regular corolla are either bell-shaped or funnel-shaped; those with an irregular one either anomalous or labiate. Herbs with a simple, polypetalous, regular corolla are either cruciform, rosaceous, umbellate, pink-like or liliaceous; those with an irregular one, papilionaceous or anomalous. The subdivisions of the classes are founded on the fruit.

It is easy to perceive that a system of this kind can never provide for all the forms of corolla which may be discovered after its first contrivance; and therefore the celebrated Dr. Garden, who studied by it, assured me, that when he attempted to reduce the American plants to Tournefort's classes, he found them so untractable, that, after attempting in vain to correct or augment the system, he should probably have given up the science in despair, had not the works of Linnæus fallen in his way.

Magnol, Professor at Montpellier, and even Linnæus himself, formed schemes of arranging plants by the calyx, which nobody has followed.

All preceding systems, and all controversies respecting their superior merits, were laid aside, as soon as the famous Linnæan method of classification, founded on the Stamens and Pistils, became known in the botanical world. Linnæus, after proving these organs to be the most essential of all to the very being of a plant, first conceived the fortunate idea of rendering them subservient to the purposes of methodical arrangement, taking into consideration their number, situation and proportion. How these principles are applied, we shall presently explain; but some previous observations are necessary.

Linnæus first made a distinction between a *natural* and an *artificial* method of botanical arrangement. His predecessors probably conceived their own systems to be each most consonant with the order of Nature, as well as most commodious for use, and it was reserved for him to perceive and to explain that these were two very distinct things.

The most superficial observer must perceive something of the classification of Nature. The Grasses, Umbelliferous plants, Mosses, Sea-weeds, Ferns, Liliaceous plants, Orchises, Compound flowers, each constitute a family strikingly similar in form and qualities among themselves, and no less evidently distinct from all others. If the whole vegetable kingdom could with equal facility be distributed into tribes or classes, the study of Botany on such a plan would be no less easy than satisfactory. But as we proceed in this path, we soon find ourselves in a labyrinth. The natural orders and families of plants, so far from being connected in a regular series, approach one another by so many points, as to bewilder instead of directing us. We may seize some striking combinations and analogies; but the further we proceed, the more we become sensible that, even if we had the whole vegetable world before us at one view, our knowledge must be imperfect, and that our "genius" is certainly not "equal to the Majesty of Nature." Nevertheless Linnæus, and all true philosophical botanists, since the first mention of the natural affinities of plants, have ever considered them as the most important and interesting branch, or rather the fundamental part, of systematical botany. Without them the science is truly a study of words, contributing nothing to enlarge, little worthy to exercise, a rational mind. Linnæus therefore suggests a scheme which he modestly calls *Fragments of a Natural Method*, which formed the subject of his occasional contemplation; but he daily and hourly studied the principles of natural affinities among plants, conscious that no true knowledge of their distinctions, any more than of their qualities, could be obtained without; of which important truth he was not only the earliest, but ever the most strenuous assertor.

In the mean while, however, Linnæus, well aware that a *natural* classification was scarcely ever to be completely discovered, and that if discovered it would probably be too difficult for common use, contrived an *artificial* system, by which plants might conveniently be arranged, like words in a dictionary, so as to be most readily found. If all the words of a language could be disposed according to their abstract derivations, or grammatical affinities, such a performance might be very instructive to a philosopher, but would prove of little service to a young scholar; nor has it ever been mentioned as any objection to the use of a dictionary, that words of very different meanings, if formed of nearly the same letters, often stand together. The Method of Linnæus therefore is just such a dictionary in Botany, while his *Philosophia Botanica* is the grammar, and his other works contain the history, and even the poetry, of the science.

But before we give a detail of his artificial system, we must first see how this great man fixed the fundamental principles of botanical science. Nor are these principles confined to botany, though they originated in that study. The Linnæan style of discriminating plants, has been extended by himself and others to animals and even fossils; and his admirable principles of nomenclature are applied with great advantage even to chemistry itself, now become so vast and accurate a science.

Independently of all general methods of classification, whether natural or artificial, plants, as well as animals, are distinguished into *Genera**, *Species*, and *Varieties*.

By Species are understood so many individuals, or, among the generality of animals, so many pairs, as are presumed to have been formed at the creation, and have been perpetuated ever since; for though some animals appear to have been exterminated, we have no reason to suspect any new species has been produced; neither have we any cause to suppose any species of plant has been lost, nor any new one permanently established, since their first formation, notwithstanding the speculations of some philosophers. We frequently indeed see new Varieties, by which word is understood a variation in an established species; but such are imperfectly, or for a limited time, if at all, perpetuated in the offspring.

A Genus comprehends one or more species, so essentially different in formation, nature, and often many adventitious qualities, from other plants, as to constitute a distinct family or kind, no less permanent, and founded in the immutable laws of the creation, than the different species of such a genus. Thus in the animal kingdom, a horse, ass and zebra form three species of a very distinct genus, marked, not only by its general habit or aspect, its uses and qualities, but also by essential characters in its teeth, hoofs, and internal constitution. The lion, tiger, leopard, panther, lynx, cat, &c., also compose another sufficiently obvious and natural genus, and the numerous herd of monkeys, apes and baboons a third. The hippopotamus is, as far as we know, a solitary species of a most distinct and striking genus; and the elephant has, till lately, been thought to stand alone in another.

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* Our scientific language in English is not sufficiently perfect to afford a plural for genus, and we are therefore obliged to adopt the Latin one, genera, though it exposes us sometimes to the horrors of hearing of "*a* new *genera*" of plants.

So among vegetables, the various species of rose compose a beautiful genus, known to every one who ever looked at a plant, merely by a certain combination of ideas, but essentially distinguished, as we shall hereafter find, by clear and decisive characters. The species of *Iris* form also a numerous genus, and the Willows another; while the curious *Epimedium alpinum, Engl. Bot. t.* 438, is too singular and distinct to be associated with any known plant besides, and constitutes a genus by itself, as well as the *Adoxa, t.* 453, and *Linnæa, t.* 433.

The first great and successful attempt to define the genera of plants was made by Tournefort, and in this his transcendent merit will ever be conspicuous, though his system of arrangement should be entirely forgotten. Not that he has excelled in verbal definitions, nor built all his genera on sure foundations; but his figures, and his enumerations of species under each genus, show the clearness of his conceptions, and rank him as the father of this branch of botany.

Linnæus first insisted on generic characters being exclusively taken from the seven parts of fructification, and he demonstrated these to be sufficient for all the plants that can be discovered. He also laid it down as a maxim, that all genera are as much founded in nature as the species which compose them; and hence follows one of the most just and valuable of all his principles, that *a genus should furnish a character, not a character form a genus*; or, in other words, that a certain coincidence of structure, habit, and perhaps qualities, among a number of plants, should strike the judgement of a botanist, before he fixes on one or more technical characters, by which to stamp and define such plants as one natural genus. Thus the *Hemerocallis cærulea*, *Andr. Repos. t.* 6, and *alba*, *t.* 194, though hitherto referred by all botanists to that genus, are so very different from the other species in habit, that a discriminative character might with confidence be expected in some part or other of their fructification, and such a character is accordingly found in the winged seeds. Yet in the natural genera of *Arenaria* and *Spergula*, winged or bordered seeds are so far from indicating a distinct genus, that it is doubtful whether they are sufficient to constitute even a specific character. See *Engl. Bot. t.* 958, 1535 and 1536. So *Blandfordia*, *Exot. Bot. t.* 4, is well distinguished from *Aletris*, with which some botanists have confounded it, by its hairy seeds; but the same circumstance will not justify us in separating a few species from *Convolvulus*, which are attached to that genus by stronger ties of another kind.

Some genera are obvious and indubitable both in habit and character, as *Quercus*, *Rosa*, *Euphorbia*, *Begonia*, *Exot. Bot. t.* 101, and *Sarracenia*, *t. 53*; others are obvious, but their character extremely difficult to define, as *Valeriana*. The greatest difficulty lies in distinguishing genera that belong to such very natural orders as the Grasses and Umbelliferous plants; and the ablest botanists differ about the best guides in these two particular cases. Yet other orders, equally natural, sometimes afford very excellent generic differences, as that to which *Rosa*, *Rubus*, *Fragaria*, &c., belong; and even in the Papilionaceous plants with ten distinct stamens, a tribe hitherto judged inextricable, a regular examination on scientific principles has led to the discovery of very natural well defined genera. See *Annals of Botany*, *v.* 1. 501. I have in a preceding chapter hinted that the umbelliferous plants seem to me very capable of being well discriminated by their seeds, and other botanists have held the same opinion.

But though I feel convinced, as far as my experience goes, that genera are really founded in nature, I am far from asserting that Linnæus, or any other writer, has succeeded in fixing all their just limits. This deep and important branch of natural science requires the union of various talents. Many persons who can perceive a genus cannot define it; nor do acuteness of perception, solidity of judgement, and perspicuity of expression, always meet in the same person. Those who excel in this department are named by Linnæus, *Phil. Bot. sect.* 152, theoretical botanists; those who study only species and varieties, practical ones.

In methodical arrangement, whether natural or artificial, every thing must give way to generic distinctions. A natural system which should separate the species of a good genus, would, by that very test alone, prove entirely worthless; and if such a defect be sometimes unavoidable in an artificial one, contrivances must be adopted to remedy it; of which Linnæus has set us the example, as will hereafter be explained.

Generic characters are reckoned by Linnæus of three kinds, the *factitious*, the *essential*, and the *natural*, all founded on the fructification alone, and not on the inflorescence, nor any other part.

The first of these serves only to discriminate genera that happen to come together in the same *artificial* order or section; the second, to distinguish a particular genus, by one striking mark, from all of the same *natural* order, and consequently from all other plants; and the third comprehends every possible mark common to all the species of one genus.

The *factitious* character can never stand alone, but may sometimes, commodiously enough, be added to more essential distinctions, as the insertion of the petals in *Agrimonia*, *Engl. Bot. t*, 1335, indicating the natural order to which the plant belongs, which character, though essential to that order, here becomes factitious.

Linnæus very much altered his notions of the *essential* character after he had published his *Philosophia Botanica*, whence the above definitions are taken. Instead of confining it to one mark or idea, he, in his *Systema Vegetabilium*, makes it comprehend all the distinctions requisite to discriminate each genus from every other in the system, only avoiding a repetition at every step of the characters of the artificial class and order, which stand at the top of each page, and are not always essential to the character of the genus. This is the kind of generic character now universally adopted, and indeed the only one in common use. The learned Jussieu has given it the sanction of his approbation and adoption, as far as its plan is concerned, throughout his immortal work, subjoining in a different type such characters and remarks as belong to the habit, or refer to other circumstances. For my own part I profess to retain, not only the plan, but the very words of Linnæus, unless I find them erroneous, copying nothing without examination, but altering with a very sparing hand, and leaving much for future examination. I cannot blame my predecessors for implicitly copying the Linnæan characters, nor should I have been the first among English writers to set a contrary example, had I not fortunately been furnished with peculiar materials for the purpose.

The beauty and perfection of these essential generic characters consist in perspicuity, and a clear concise style of contrasting them with each other. All feebleness, all superfluity, should be avoided by those who are competent to the purpose, and those who are not should decline the task. Comparative words, as *long* or *short*, without any scale of comparison, are among the grossest, though most common, faults in such compositions.

The *natural* character seems to have been, at one time, what Linnæus most esteemed. It is what he has used throughout his *Genera Plantarum*, a work now superseded by the essential characters in his *Systema Vegetabilium*, and therefore in some measure laid aside. The disadvantages of the natural character are, that it does not particularly express, nor direct the mind to, the most important marks, and that it can accord only with such species of the genus as are known to the author, being therefore necessarily imperfect. This kind of character is, however, admirable for the illustration of any difficult natural order. Mr. Gawler's elucidations of the *Ensatæ*, Sword-leaved plants, *Annals of Botany*, *v.* 1. 219, and *Curt. Mag.* afford excellent specimens of it, serving as a store of facts and observations for following systematical writers.

Specific characters should be constructed on similar principles to the generic ones, as far as regards certainty, clearness and conciseness. The genus being first well defined, we are to seek for characters, not mentioned among the generic marks, for distinguishing the species. A specific difference for a solitary species of any genus, is therefore an absurdity. Linnæus at first intended his specific definitions should be used as names; but the invention of trivial names happily set aside this inconvenient scheme. On this account however he limited each to twelve words, a rule to which all philosophical naturalists have adhered, except in cases of great necessity. Nor is the admission of one or two words beyond the allotted number reprehensible, provided the whole sentence be so neatly and perspicuously constructed, that the mind may comprehend it, and compare it with others, at one view; but this can hardly be done when the words much exceed twelve. This rule, of course, can be strictly applied to Latin definitions only, though it should be kept in view in any language, as far as the genius of that language will allow. Linnæus says, "Genuine specific distinctions constitute the perfection of natural science;" which is strongly confirmed by the great inferiority of most botanists, in this department, to that great man, and especially by the tedious feebleness and insufficiency, displayed among those who court celebrity by despising his principles.

In constructing generic and specific characters, the arrangement of the different parts on which they are founded is to be considered. Such as are most important in the natural order, or genus, are to stand first, and the subordinate, or more peculiar marks of the object before us, ought to close the sentence. On the contrary, in drawing up natural characters of a genus, as well as full descriptions of particular plants, it is proper to take, in the former instance, the calyx, corolla, stamens, pistils, seed-vessel, seed and receptacle; and in the latter, the root, stem, leaves, appendages, flower and fruit, in the order in which they naturally occur.

Nomenclature is no less essential a branch of methodical science than characteristic definitions; for, unless some fixed laws, or, in other words, good sense and perspicuity, be attended to in this department, great confusion and uncertainty must ensue.

The vague names of natural objects handed down to us, in various languages, from all antiquity, could have no uniformity of derivation or plan in any of those languages. Their different origins may be imagined, but cannot be traced. Many of these, furnished by the Greek or Latin, are retained as generic names in scientific botany, though neither their precise meaning, nor even the plants to which they originally belonged, can always be determined, as *Rosa*, *Ficus*, *Piper*, &c. It is sufficient that those to which they are now, by common consent, applied, should be defined and fixed. Botanists of the Linnæan school, however, admit no such generic names from any other language than the Greek or Latin, all others being esteemed barbarous. Without this rule we should be overwhelmed, not only with a torrent of uncouth and unmanageable words, but we should be puzzled where to fix our choice, as the same plant may have fifty different original denominations in different parts of the world, and we might happen to choose one by which it is least known. Thus, the celebrated Indian plant now proved beyond all doubt to be the *Cyamus* of Theophrastus*, having been erroneously reckoned by Linnæus a *Nymphæa*, received from Gærtner, one of the first who well distinguished it as a genus, the Ceylon name of *Nelumbo*; which being contrary to all rules of science, literature, or taste for a generic name, has by others been made into bad Latin as *Nelumbium*. But the universal Hindu name of the plant is *Tamarà*, which, independent of barbarism, ought to have been preferred to the very confined one of *Nelumbo*. In like manner the Bamboo, *Arundo Bambos* of Linnæus, proving a distinct genus, has received the appellation of *Bambusa*, though Jussieu had already given it that of *Nastus* from Dioscorides†. Perhaps the barbarous name of some very local plants, when they cannot possibly have been known previously by any other, and when that name is harmonious and easily reconcileable to the Latin tongue, may be admitted, as that of the Japan shrub *Aucuba*; but such a word as *Ginkgo* is intolerable. The Roman writers, as Cæsar, in describing foreign countries, have occasionally latinized some words or names that fell in their way, which may possibly excuse our making *Ailanthus* of *Aylanto*, or *Pandanus* of *Pandang*. Still I can only barely tolerate such names out of deference to the botanical merits, not the learning, of their contrivers; and I highly honour the zeal and correctness of Mr. Salisbury, who, in defiance of all undue authority, has ever opposed them, naming *Aucuba*, on account of its singular base or receptacle, *Eubasis*. I know not how *Pandanus* escaped his reforming hand, especially as the plant has already a good characteristic Greek name in the classical Forster, *Athrodactylis*.

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* See *Exot. Bot.* *v.* 1. 60, where the arguments in support of this opinion are given, and *Curt. Mag. t.* 903, where some of them are with much candour and ingenuity controverted, though not so as to alter my sentiments; nor can any thing justify the use of *Nelumbium* in a scientific work as a *generic* name.

† It is not indeed clear that this name is so correctly applied as that of *Cyamus*, because *Nastus* originally belonged to "a reed with a solid stem," perhaps a palm; but not being wanted, nor capable of being correctly used, for the latter, it may very well serve for the Bamboo. There is no end of raking up old uncertainties about classical names.

Excellent Greek or Latin names are such as indicate some striking peculiarity in the genus: as *Glycyrrhiza*, a sweet root, for the Liquorice; *Amaranthus*, without decay, for an everlasting flower; *Helianthus*, a sunflower; *Lithospermum*, a stony seed; *Eriocalia**, a flower with a singularly woolly base or cup; *Origanum*, an ornamental mountain plant; *Hemerocallis*, a beauty of a day; *Arenaria*, a plant that inhabits sandy places; and *Gypsophila*, one that loves a chalky soil. Such as mark the botanical character of the genus, when they can be obtained for a nondescript plant, are peculiarly desirable; as *Ceratopetalum*, from the branched horn-like petals; *Lasiopetalum*, from the very singularly woolly corolla; *Calceolaria*, from the shoe-like figure of the same part; *Conchium*, from the exact resemblance of its fruit to a bivalve shell.

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* When I named this genus in Exotic Botany, I was not aware of its having previously been published by M. Billardiere under the name of *Actinotus*; a name however not tenable in Botany, because it has long been preoccupied in Mineralogy.

In all ages it has been customary to dedicate certain plants to the honour of distinguished persons. Thus *Euphorbia* commemorates the physician of Juba a Moorish prince, and *Gentiana* immortalizes a king of Illyria. The scientific botanists of modern times have adopted the same mode of preserving the memory of benefactors to their science; and though the honour may have been sometimes extended too far, that is no argument for its total abrogation. Some uncouth names thus unavoidably deform our botanical books; but this is often effaced by the merits of their owners, and it is allowable to model them into grace as much as possible. Thus the elegant Tournefort made *Gundelia* from Gundelscheimer; which induced me to choose *Goodenia*, for my much honoured and valued friend Dr. Goodenough, now Bishop of Carlisle, though it has, when too late, been suggested that *Goodenovia* might have been preferable. Some difficulty has arisen respecting French botanists on account of the additional names by which their grandeur, or at least their vanity, was displayed during the existence of the monarchy. Hence *Pittonia* was applied to the plant consecrated to Pitton de Tournefort; but Linnæus preferred the name by which alone he was known out of his own country, or in learned language, and called the same genus *Tournefortia.* Thus we have a *Fontainesia* and a *Louichea*, after the excellent Louiche Desfontaines; but the latter proving a doubtful genus, or, if a good one, being previously named *Pteranthus*, the former is established. We have even in England, by a strange oversight, both *Stuartia* and *Butea* after the famous Earl of Bute; but the former being long ago settled by Linnæus, the latter, since given by Kœnig, is totally inadmissible on any pretence whatever, and the genus which bears it must have a new appellation. In like manner my own *Humea*, *Exot. Bot. t.* 1, has been called in France *Calomeria* after the present Emperor, by the help of a pun, though there has long been another genus *Bonapartea*, which last can possibly be admitted only in honour of the divorced Empress, and not of her late consort, who has no botanical pretensions. Our own beloved sovereign could derive no glory from the *Georgia** of Ehrhart; but the *Strelitzia* of Aiton stands on the sure basis of botanical knowledge and zeal, to which I can bear ample and very disinterested testimony.

Linnæus, in his entertaining book *Critica Botanica*,

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* *Tetraphis* of Hedwig, and *Engl. Bot. t.* 1020.

p. 79, has in several instances drawn a fanciful analogy between botanists and their appropriate plants, thus—

Bauhinia, after the two distinguished brothers John and Caspar Bauhin, has a two-lobed or twin leaf.

Scheuchzeria, a grassy alpine plant, commemorates the two Scheuchzers, one of whom excelled in the knowledge of alpine productions, the other in that of grasses.

Dorstenia, with its obsolete flowers, devoid of all beauty, alludes to the antiquated and uncouth book of Dorstenius.

Hernandia, an American plant, the most beautiful of all trees in its foliage, but furnished with trifling blossoms, bears the name of a botanist highly favoured by fortune, and allowed an ample salary for the purpose of investigating the natural history of the Western world, but whose labours have not answered the expense. On the contrary

Magnolia with its noble leaves and flowers, and

Dillenia with its beautiful blossoms and fruit, serve to immortalize two of the most meritorious among botanists.

Linnæa, "a depressed, abject, Lapland plant, long overlooked, flowering at an early age, was named by Gronovius after its prototype Linnæus."

In pursuance of the same idea, *Dicksonia*, a beautiful and curious fern, is well devoted to our great cryptogamist; *Knappia*, a small and singular grass, to an author celebrated for his minute and curious drawings of that tribe; *Sprengelia*, to one distinguished for illustrating the impregnation of plants, which the remarkable form and union of its anthers serve to indicate; while *Smithia sensitiva*, named by Mr. Dryander in the *Hortus Kewensis* of our mutual friend Aiton, could at that time be merited only by a treatise on the Irritability of Plants*, to which the specific name happily alludes.

The generic name being fixed, the specific one is next to be considered. With respect to this, Rivinus has the merit of originality, having been the first to contrive naming each plant in two words. But his names were meant for specific definitions, for which they are totally inadequate. Linnæus, in constructing his more accurate and full specific characters, intended the latter should serve as names, and thefore called them *nomina specifica.* When he, most fortunately for the science and for the popularity of his whole System of Nature, invented the present simple specific names, he called them *nomina trivialia*, trivial, or for common use; but that term is now superfluous.

Specific names should be formed on similar principles to the generic ones; but some exceptions are allowed, not only without inconvenience, but with great advantage. Such as express the essential specific character are unexceptionable, as *Banksia serrata*, *integrifolia*, *dentata*, &c.; but perhaps those which express something equally certain, but not comprehended in that character, are still more useful, as conveying additional information, like *Ixora alba* and *coccinea*, *Scleranthus annuus* and *perennis*, *Aletris fragrans*, *Saxifraga cernua*, &c.; for which reason it is often useful that vernacular names should not be mere translations of the Latin ones. Comparative appellations are very good, as *Banksia ericifolia*, *Andromeda salicifolia**, *Saxifraga bryoides*, *Milium cimicinum*, *Elymus Hystrix*, *Pedicularis Sceptrum*. Names which express the local situations of different species are excellent, such as *Melampyrum arvense*, *pratense*, *nemorosum* and *sylvaticum*, *Carex arenaria*, *uliginosa* and *sylvatica*, as well as *aquatica*, *maritima*, *rupestris*, *alpina*, *nivalis*, used for many plants. But names derived from particular countries or districts are liable to much exception, few plants being sufficiently local to justify their use. Thus *Ligusticum cornubiense* is found, not only in Cornwall, but in Portugal, Italy and Greece; *Schwenkia americana* grows in Guinea as well as in South America. Such therefore, though suffered to remain on the authority of Linnæus, will seldom or never be imitated by any judicious writer, unless *Trollius europæus* and *asiaticus* may justify our naming the third species of that genus, lately brought from America, *americanus*. The use of a plant is often commodiously expressed in its specific name, as *Brassica oleracea*, *Papaver somniferum*, *Inocarpus edulis*; so is likewise its time of flowering, as *Primula veris*, *Leucojum vernum*, *æstivum* and *autumnale*, and *Helleborus hyemalis*.

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* *Phil. Trans. for* 1788.

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* Some botanists write *ericæfolia*, *salicisfolia*, *linguæformis*, &c., instead of following the analogy of the Latin in forming adjectives with an *i*, as *palmifer* from *palma*, *æ*; *baccifer*, from *bacca*, *æ*; *barbiger*, from *barba*, *æ*; &c.

When a plant has been erroneously made into a new genus, the name so applied to it may be retained for a specific appellation, as *Lathræa Phelypæa*, and *Bartsia Gymnandra*; which may also be practised when a plant has been celebrated, either in botanical, medical, or any other history, by a particular name, as *Origanum Dictamnus*, *Artemisia Dracunculus*, *Laurus Cinnamomum*, *Selinum Carvifolia*, *Carica Papaya*. In either case the specific name stands as a substantive, retaining its own gender and termination, and must begin with a capital letter; which last circumstance should be observed if a species be called after any botanist who has more particularly illustrated it, as *Cortusa Matthioli* and *C. Gmelini*, *Duranta Plumierii*, and *Mutisii*. The latter genus suggests an improvement in such kind of names. The genitive case is rightly used for the person who founded the genus, *D. Plumierii*; *D. Mutisiana* might serve to commemorate the finder of a species, while *D. Ellisia* implies the plant which bears it to have been once called *Ellisia*.

There is another sort of specific names in the genitive case, which are to me absolutely intolerable, though contrived by Linnæus in his latter days. These are of a comparative kind, as *Lobelia Columneæ*, meaning *Columneæformis*. We may allow a few such, already established, to remain, but no judicious author will imitate them.

Botanists occasionally adapt a specific name to some historical fact belonging to the plant or to the person whose name it bears, as *Linnæa borealis* from the great botanist of the north; *Murræa exotica* after one of his favourite pupils, a foreigner; *Browallia demissa* and *elata*, from a botanist of humble origin and character, who afterwards became a lofty bishop, and in whose work upon water I find the following quotation from Seneca in the hand-writing of Linnæus: "Many might attain wisdom, if they did not suppose they had already reached it." In like manner *Buffonia tenuifolia* is well known to be a satire on the *slender* botanical pretensions of the great French zoologist, as the *Hillia parasitica* of Jacquin, though perhaps not meant, is an equally just one upon our pompous Sir John Hill. I mean not to approve of such satires. They stain the purity of our lovely science. If a botanist does not deserve commemoration, let him sink peaceably into oblivion. It savours of malignity to make his crown a crown of thorns, and if the application be unjust, it is truly diabolical.

Before I conclude the subject of nomenclature, I beg leave to offer a few reflections on changes of established names. It is generally agreed among mankind that names of countries, places, or things, sanctioned

A great and just complaint has arisen in my time among the cultivators of botany, who found the names of many garden plants, with which they had long been conversant, altered for others without any apparent cause, and in many instances for the worse; as *Aristolochia macrophylla*, an excellent and expressive name, for a very unappropriate one, *A. Sipho*. For this I am obliged to censure my much regretted and very intelligent friend L'Heritier. When he came to England to reap the rich harvest of our undescribed plants, he paid no respect to the generic or specific names by which Dr. Solander or others had called them, because those names were not printed; but he indulged himself, and perhaps thought he confirmed his own importance, by contriving new ones; a factitious mode of gaining celebrity, to which his talents ought to have been infinitely superior. Nor would it have been easy to say how far this inconvenient plan of innovation might have extended, had not the *Hortus Kewensis* come forth to secure our remaining property.

I have only to add a few words respecting a kind of generic names that has of late become more common than Linnæus probably would have approved, though he has once or twice allowed it. I allude to those compounded either of two established names, or of one combined with any other word. Of the former number is *Calamagrostis*, formed of *Calamus* and *Agrostis*, two Linnæan names; and this is no where sanctioned by any good authority. Happily the genus to which it has negligently been applied is an *Arundo*. Of the latter sort is *Cissampelos*, formed of *Cissus*, another established genus, and *Ampelos*, a Vine; the latter not among Linnæan names: also *Elæagnus*, constructed of two old Greek names, neither of which is now in botanical use by itself. These are both expressly allowed by Linnæus, nor indeed can there be any objection to the latter. *Cissampelos* may certainly justify *Hyoscyamus*, composed of *Cyamus* and a word denoting swine; if not, this would prove an objection to the reestablishment of *Cyamus*, much more to the purpose than any that has been advanced; for *Hyoscyamus* having been so long and universally used in systematic botany, could scarcely give place, even to its venerable prototype. On the same ground only can several new generic names, used in the fern tribe, be admitted. These are formed out of *Pteris*, the established generic appellation of a common Brake, with some other Greek word prefixed; as *Angiopteris*, a Brake with a capsule, *Tmesipteris*, a cloven Brake, and *Cænopteris*, a *new* Brake. Whatever may become of the former two, I must always protest against the last, given by the celebrated Bergius to the *Darea* of Jussieu, on account of its unexampled impropriety. As well might any new genus, resembling a Rose, be called *Novarosa*; for though the Greek language may assist us with regard to *sound*, it can never make amends for a radical deficiency of *sense*.

CHAPTER XXIII.

EXPLANATION OF THE LINNÆAN ARTIFICIAL SYSTEM.

The Linnæan System is, as I have already observed, professedly artificial. Its sole aim is to help any one to learn the name and history of an unknown plant in the most easy and certain manner, by first determining its Class and Order in this system; after which its Genus is to be made out by comparing the parts of fructification with all the generic characters of that Order; and finally its Species, by examining all the specific definitions of the Genus. We thus ascertain the generic and specific name of our plant in Linnæus, and under those we find an enumeration, more or less ample, of its Synonyms, or the different appellations it has received from other writers, with a reference to figures in various books; and as Linnæus always cites Bauhin's *Pinax*, which is the common botanical catalogue, or index to all previous works, we thus gain a clue to every thing recorded concerning our plant. Of all this mass of information and entertainment we shall find nothing more concise, luminous, or engaging, either with respect to the distinctions, uses, or history of plants, than what is diffused through the various publications of Linnæus himself; and the same may, with at least equal truth, be said of those of his works which illustrate the Animal kingdom. His magic pen turns the wilds of Lapland into fairy land. He has all the animals of Sweden as much at his call, as our first parent while the terrestrial paradise was yet in primæval tranquillity. No writer whatever has rendered the natural productions, of the happiest and most luxuriant climates of the globe, half so interesting or instructive, as Linnæus has made those of his own northern country.

The CLASSES of the Linnæan System are 24, and their distinctions are founded on the number, situation, or proportion of the Stamens. The Orders are founded either on the number of the Pistils, or on some circumstance equally easy, which we shall in due time explain.

The first eleven Classes are characterized solely by the number of the Stamens, and distinguished by names, of Greek derivation, expressive of these distinctions.

1. MONANDRIA. Stamen 1.
A small Class.
2. DIANDRIA. Stamens 2.
3. TRIANDRIA ——— 3.
4. TETRANDRIA ——— 4.
5. PENTANDRIA ——— 5.
A numerous Class.
6. HEXANDRIA ——— 6.

7. HEPTANDRIA Stamens 7.
A very small Class.
8. OCTANDRIA ——— 8.
9. ENNEANDRIA ——— 9.
A small Class.
10. DECANDRIA. ——— 10.
11. DODECANDRIA ——— 12 to 19.
12. ICOSANDRIA ——— 20 or more Stamens, *inserted into the Calyx.* Here we first find the *situation* of the Stamens taken into consideration. They grow out of the sides of the Calyx, often from a sort of ring, as in the Strawberry. This is truly a natural Class, as are several of the following ones; so that in these instances the Linnæan method of arrangement performs more than it promises. The character of this Class is the more important, as such a mode of insertion indicates the pulpy fruits which accompany it to be infallibly wholesome, and this holds good, not only when the stamens are numerous, but in all other cases. Thus *Ribes*, the Currant and Gooseberry genus, whose five stamens grow out of the calyx, stands in the fifth Class, a wholesome fruit, among many poisonous berries. No traveller in the most unknown wilderness need scruple to eat any fruit whose stamens are thus situated; while on the other hand he will do well to be cautious of feeding on any other parts of the plant.

13. **Polyandria.** Stamens numerous, commonly more so than in the last Class, and *inserted into the Receptacle*, or base of the flower, as in the Poppy, Anemone, &c. The plants of this fine and numerous Class are very distinct in nature, as well as character, from those of the *Icosandria*.

14. **Didynamia.** Stamens two long and two short. Here *proportion* comes to our assistance. This is a natural Class, and contains most of the labiate, ringent or personate flowers, as the Dead-nettle, Snap-dragon, Fox-glove, &c.

15. **Tetradynamia.** Stamens four long and two short. A very natural Class, comprehending all the Cruciform flowers, as the Wall-flower, Stock, Radish, Mustard, &c. *Cleome* only does not properly belong to the rest.

16. **Monadelphia.** Stamens united by their filaments, more or less extensively, into one tube, as the Mallow tribe, in which such union is very remarkable, and the Geranium family, in which it is less evident.

17. **Diadelphia.** Stamens united into two parcels, both sometimes cohering together at the base. This Class consists of Papilionaceous flowers, and is therefore natural, except that some such genera, having

distinct Stamens, are excluded, and referred to the tenth Class, in consideration of their number solely; as some ringent flowers with only two Stamens are necessarily placed, not in the fourteenth Class, but the second.

18. POLYADELPHIA. Stamens united into more than two parcels, as in St. John's-wort. A small Class, in some points related to *Icosandria*.

19. SYNGENESIA. Stamens united by their Anthers into a tube, rarely by their Filaments also; and the flowers are Compound. A very natural and extremely numerous Class. Examples of it are the Dandelion, Daisy, Sunflower, &c.

20. GYNANDRIA. Stamens united with, or growing out of, the Pistil; either proceeding from the Germen, as in *Aristolochia*, *Engl. Bot. t.* 398, or from the Style, as in the Orchis family. The Passion-flower is wrongly put by Linnæus and others into this Class, as its stamens merely grow out of an elongated receptacle or column supporting the Germen.

21. MONOECIA. Stamens and Pistils in separate flowers, but both growing on the same plant, or, as the name expresses, dwelling in one house, as the Oak, Hazle, and Fir.

22. DIOECIA. Stamens and Pistils not only in separate flowers, but those flowers situated on two separate plants, as in the Willow, Hop, Yew, &c.

These two last Classes are natural when the barren flowers have, besides the difference in their essential organs, a different structure from the fertile ones in other respects; but not so when they have the same structure, because then both organs are liable to meet in the same flower. In some plants, as *Rhodiola*, *Engl. Bot. t.* 508, each flower has always the rudiments of the other organ, though generally inefficient.

23. POLYGAMIA. Stamens and Pistils separate in some flowers, united in others, either on the same plant, or on two or three different ones.

This Class is natural only when the several flowers have a different structure, as those of *Atriplex*; but in this genus the Pistil of the united flower scarcely produces seed. If, with Linnæus, we admit into *Polygamia* every plant on which some separated barren or fertile flowers may be found among the united ones, while all agree in general structure, the Class will be overwhelmed, especially with Indian trees. I have therefore proposed that regard should be had to their general structure, which removes all such inconvenience, and renders the Class much more natural.

24. **Cryptogamia.** **Stamens and Pistils either not well ascertained, or not to be numbered with any certainty, insomuch that the plants cannot be referred to any of the foregoing Classes. Of this Ferns, Lichens, Sea-weeds and Mushrooms are examples.**

Appendix. PALMÆ, Palm-trees, a magnificent tribe of plants, chiefly tropical, whose flowers were too little known, when Linnæus wrote, to serve the purposes of classification; but they are daily clearing up, and the Palms are found generally to belong to the Classes *Monoecia*, *Dioecia*, or *Hexandria*.

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The Orders of the Linnæan System are, in the first thirteen Classes, founded on the number of the Styles, or on that of the Stigmas when the Styles are wanting, which occurs in *Viburnum*. Such Orders are accordingly named

Monogynia.	Style, or sessile Stigma,	1.
Digynia.	Styles, or sessile Stigmas,	2.
Trigynia	——————	3.
Tetragynia	——————	4.
Pentagynia	——————	5.
Hexagynia	——————	6.
of very rare occurrence.		
Heptagynia	——————	7.
still more unusual.		

Octagynia. Styles, or sessile Stigmas, 8, scarcely occurs at all.

Enneagynia ——————— 9, of which there is hardly an instance.

Decagynia ——————— 10.

Dodecagynia ——————— about 12.

Polygynia ——————— many.

The two Orders of the fourteenth Class, *Didynamia*, both natural, are characterized by the fruit, as follows:

1. Gymnospermia. Seeds naked, almost universally four, never more.
2. Angiospermia. Seeds in a capsule, numerous.

The two Orders of the fifteenth Class, *Tetradynamia*, both very natural, are distinguished by the form of the fruit, thus:

1. Siliculosa. Fruit a *Silicula*, Pouch, or roundish Pod.
2. Siliquosa. Fruit a Siliqua, or long Pod.

The Orders of the sixteenth, seventeenth and eighteenth Classes, *Monadelphia*, *Diadelphia* and *Polyadelphia*, are founded on the number of the Stamens, that is, on the characters of the first thirteen Classes.

The Orders of the great natural nineteenth Class, *Syngenesia*, are marked by the united or separated, barren, fertile, or abortive, nature of the florets.

1. Polygamia æqualis. Florets all perfect or united, that is, each furnished with perfect Stamens, a Pistil, and one Seed.

2. POLYGAMIA SUPERFLUA. Florets of the disk with Stamens and Pistil; those of the radius with Pistil only, but each, of both kinds, forming perfect Seed.

3. POLYGAMIA FRUSTRANEA. Florets of the disk as in the last; those of the radius with merely an abortive Pistil, or with not even the rudiments of any. This is a bad Order, for reasons hereafter to be explained.

4. POLYGAMIA NECESSARIA. Florets of the disk with Stamens only, those of the radius with Pistils only.

5. POLYGAMIA SEGREGATA. Several flowers, either simple or compound, but with united anthers, and with a proper calyx, included in one common calyx.

Linnæus has a sixth Order in this Class, named *Monogamia*, consisting of simple flowers with united anthers; but this I have presumed to disuse, because the union of the anthers is not constant throughout the species of each genus referred to it, witness *Lobelia* and *Viola*, while on the contrary several detached species in other Classes have united anthers, as in *Gentiana*, *Engl. Bot. t.* 20. These reasons, which show the connection of the anthers of a simple flower to be neither important in nature, nor constant as an artificial character, are confirmed by the plants of this whole Linnæan Order being natural allies of others in the fifth Class, and totally discordant, in every point, from the compound syngenesious flowers.

The Orders of the twentieth, twenty-first and twenty-second Classes are distinguished by the characters of some of the Classes themselves which precede them, that is, almost entirely by the number of their Stamens; for the union of the anthers in some of them is, for the reasons just given, of no moment.

The Orders of the twenty-third Class, *Polygamia*, are, according to the beautiful uniformity of plan which runs through this ingenious system, distinguished upon the principles of the Classes immediately preceding.

1. MONOECIA has flowers with Stamens and Pistils on the same plant with others that have only Pistils, or only Stamens; or perhaps all these three kinds of blossoms occur; but whatever the different kinds may be, they are confined to one plant.
2. DIOECIA has the two or three kinds of flowers on two separate plants.
3. TRIOECIA has them on three separate plants, of which the Fig is the only real example, and in that the structure of the flowers is alike in all.

The Orders of the twenty-fourth Class, *Cryptogamia*, are professedly natural. They are four in Linnæus, but we now reckon five.

1. FILICES. Ferns, whose fructification is obscure, and grows either on the back, summit, or near the base of the leaf, thence denominated a frond. See *p.* 102.

2. MUSCI. Mosses, which have real separate leaves, and often a stem; a hood-like corolla, or *calyptra*, bearing the style, and concealing the capsule, which at length rises on a stalk with the *calyptra*, and opens by a lid.

3. HEPATICÆ. Liverworts, whose herb is a frond, being leaf and stem united, and whose capsules do not open with a lid. Linnæus comprehends this Order under the following.

4. ALGÆ. Flags, whose herb is likewise a frond, and whose seeds are imbedded, either in its very substance, or in the disk of some appropriate receptacle.

5. FUNGI. Mushrooms, destitute of herbage, bearing their fructification in a fleshy substance.

Such are the principles of the Linnæan Classes and Orders, which have the advantage of all other systems in facility, if not conformity to the arrangement of nature; the latter merit they do not claim. They are happily founded on two organs, not only essential to a plant, but both necessarily present at the same time; for though the Orders of the fourteenth and fifteenth Classes are distinguished by the fruit, they can be clearly ascertained even in the earliest state of the germen*.

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* An instance apparently to the contrary occurs in the history of my *Hastingia coccinea*, *Exot. Bot.* t. 80, a plant most evidently, both by character and natural affinity, belonging to the *Didynamia*

Tournefort founded his Orders on the fruit; and his countryman Adanson is charmed with the propriety of this measure, because the fruit comes after the flower, and thus precedence is given to the nobler part which distinguishes the primary divisions or Classes! But happily the laws of a drawing-room do not extend to philosophy, and we are allowed to prefer parts which we are sure to meet with at one and the same moment, without waiting a month or two, after we have made out the Class of a plant, before we can settle its Order.

The Linnæan System, however, like all human inventions, has its imperfections and difficulties. If we meet in gardens with double or monstrous flowers, whose essential organs of fructification are deformed, multiplied, or changed to petals; or if we find a solitary barren or fertile blossom only; we must be at a loss, and in such cases could only guess at a new plant from its natural resemblance to some known one. But the principal imperfection of the System in question consists, not merely in what arises from variations in number or structure among the parts of a flower, against which no system could provide, but in the dif-

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Gymnospermia, but as I could no where find it described in that Order, I concluded it to be unpublished; and was not a little surprised to be told some time afterwards, that it was extant in the works of my friends Retzius and Willdenow, under *Didynamia Angiospermia*, by the name of *Holmskioldia*, after a meritorious botanist. This last name therefore, however unutterable, must remain; and I wish the Linnæan system, as well as myself, might be as free from blame in all other cases as in this.

ferences which sometimes occur between the number of Stamens, Styles, &c., in different plants of the same natural genus. Thus, some species of *Cerastium* have only four, others five, Stamens, though the greater part have ten. *Lychnis dioica* has the Stamens on one plant, the Pistils on another, though the rest of the genus has them united in the same flower; and there are several similar instances; for number in the parts of fructification is no more invariable than other characters, and even more uncertain than such as are founded on insertion, or the connexion of one part with another. Against these inconveniences the author of this System has provided an all-sufficient remedy. At the head of every Class and Order, after the genera that properly belong to them, he enumerates, in italics, all the anomalous species of genera stationed in other places, which, by their own peculiar number of Stamens or Styles, should belong to the Class or Order in question, but which are thus easily found with their brethren by means of the index.

It is further to be observed, that Linnæus, ever aware of the importance of keeping the natural affinities of plants in view, has in each of his artificial Orders, and sections of those Orders, arranged the genera according to those affinities; while at the head of each Class, in his *Systema Vegetabilium*, he places the same genera according to their technical characters; thus combining, as far as art can keep pace with nature, the merits of a natural and an artificial system. His editors have seldom been aware of this; and Murray especially, in his fourteenth edition of the book just mentioned, has inserted new plants without any regard to this original plan of the work.

From the foregoing remarks it is easy to comprehend what is the real and highly important use of the *Genera Plantarum* of Jussieu arranged in Natural Orders, the most learned botanical work that has appeared since the *Species Plantarum* of Linnæus, and the most useful to those who study the philosophy of botanical arrangement. The aim of this excellent author is to bring the genera of plants together, as much as possible, according to their natural affinities; constructing his Classes and Orders rather from an enlarged and general view of those affinities, than from technical characters, previously assumed, for each Class or Order; except great and primary divisions, derived chiefly from the Cotyledons, the Petals, and the insertion of the Stamens. But his characters are so far from absolute, that at the end of almost every Order we find a number of genera merely related to it, and not properly belonging to it; and at the end of the system a very large assemblage of genera incapable of being referred to any Order whatever. Nor could a learner possibly use this system as a dictionary, so as to find out any unknown plant. The characters of the Orders are necessarily, in proportion as those Orders are natural, so widely and loosely constructed, that a student has no where to fix; and in proportion as they are here and there more defined, this, or any other system, becomes artificial, and liable to the more exceptions. The way therefore to use this valuable work, so as to ascertain an unknown plant, is, after turning to the Order or Genus to which we conceive it most probably allied, to read and study the characters and observations there brought together, as well as all to which they may allude. We shall find we learn more from the doubts and queries of Jussieu than from the assertions of most other writers. We shall readily perceive whether our plant be known to him or not; and if at the same time we refer it, by its artificial characters, to the Linnæan System, we can hardly fail to ascertain, even under the most difficult circumstances, whether it be described by either of these authors. A student may acquire a competent knowledge of natural orders, with very great pleasure to himself, by repeatedly turning over the work of Jussieu with any known plants in his hand, and contemplating their essential generic characters in the first place, and then what regards their habit and affinities; proceeding afterwards to combine in his own mind their several points of agreement, till he is competent to form an idea of those assemblages which constitute natural Classes and Orders. This will gradually extend his ideas; whereas a contrary mode would only contract them, and his Jussieu would prove merely an artificial guide, without the advantages of facility or perspicuity.

CHAPTER XXIV.

ILLUSTRATIONS OF THE LINNÆAN CLASSES AND ORDERS.

I PROCEED to a compendious view of the Linnæan Classes and Orders, which will serve to illustrate many things in the preceding pages.

CLASS 1. *Monandria.* Stamen 1.
This contains only two Orders.

1. *Monogynia.* Style 1. Here we find the beautiful exotic natural order called *Scitamineæ*, consisting of Cardamoms, Ginger, Turmerick, &c., hitherto a chaos, till Mr. Roscoe, in a paper printed in the eighth volume of the *Linnæan Society's Transactions*, reduced them to very natural and distinct genera by the form of the filament. See *Exot. Bot. t.* 102, 103, 106—8.

   Salicornia, *Engl. Bot. t.* 415 and 1691, and *Hippuris*, *t.* 763, are British examples of *Monandria Monogynia.*

   Valeriana (Class 3) has some species with one stamen.

2. *Digynia.* Styles 2. Contains *Corispermum*, *Fl.*

Græc. t. 1, *Blitum, Curt. Mag. t.* 276, and a few plants besides.

CLASS 2. *Diandria.* Stamens 2. Orders 3.

1. *Monogynia.* This, the most natural and numerous Order, comprehends the elegant and fragrant *Jasmineæ*, the Jasmine, Lilac, Olive, &c.—also *Veronica, Engl. Bot. t.* 2, 1027, 623, 783, &c.—and a few labiate flowers with naked seeds, as *Salvia, Engl. Bot. t.* 153, 154, Rosemary, &c., natural allies of the fourteenth class; but having only two stamens, they are necessarily ranged here in the artificial system.
2. *Digynia* consists only of *Anthoxanthum*, a grass, *Engl. Bot. t.* 647, which, for the reason just given, is separated from its natural family in the third class.
3. *Trigynia*—has only *Piper*, the Pepper, a large tropical genus.

CLASS 3. *Triandria.* Stamens 3. Orders 3.

1. *Monogynia. Valeriana, Engl. Bot. t.* 698, 1591 and 1531, is placed here because most of its species have three stamens. See Class 1. Here also we find the sword-leaved plants, so amply illustrated in Curtis's Magazine, *Iris, Gladiolus, Ixia*, &c., also *Crocus, Engl. Bot. t.* 343, 344, 491, and numerous gras-like plants, *Schœnus, Cyperus, Scirpus*, see *Fl. Græc. v.* 1, and *Engl. Bot. t.* 950, 1309, 542, 873, &c.

2. *Digynia.* This important Order consists of the true Grasses; see *p.* 99. Their habit is more easily perceived than defined; their value, as furnishing herbage for cattle, and grain for man, is sufficiently obvious. No poisonous plant is found among them, except the *Lolium temulentum*, *Engl. Bot. t.* 1124, said to be intoxicating and pernicious in bread. Their genera are not easily defined. Linnæus, Jussieu, and most botanists, pay regard to the number of florets in each spikelet; but in *Arundo* this is of no moment. Magnificent and valuable works on this family have been published in Germany by the celebrated Schreber and by Dr. Host. The *Fl. Græca* also is rich in this department, to which the late Dr. Sibthorp paid great attention. Much is to be expected from scientific agriculturists; but Nature so absolutely, in general, accommodates each grass to its own soil and station, that nothing is more difficult than to overcome their habits, insomuch that few grasses can be generally cultivated at pleasure.

3. *Trigynia* is chiefly composed of little pink-like plants, or *Caryophylleæ*, as *Holosteum*, *Engl. Bot. t.* 27.

Tillæa muscosa, *t.* 116, has the number proper to this order, but the rest of the genus bears every part of the fructification in fours. This in Linnæan language is expressed by saying the flower of *Tillæa* is *quadrifidus*[*], four-cleft, and *T. muscosa* excludes, or lays aside, one fourth of the fructification.

CLASS 4. *Tetrandria.* Stamens 4. Orders 3.

1. *Monogynia.* A very numerous and various Order, of which the *Proteaceæ* make a conspicuous part, consisting of *Protea*, *Banksia*, *Lambertia*, *Embothrium*, &c. See *Botany of New Holland*, *t.* 7—10. *Scabiosa*, *Engl. Bot. t.* 659; *Plantago*, *t.* 1558, 1559, remarkable for its *capsula circumscissa*, a membranous capsule, separating by a complete circular fissure into two parts, as in the next genus, *Centunculus*, *t.* 531; *Rubia*, *t.* 851, and others of its natural order, of whose stipulation we have spoken, *p.* 167, are found here, and the curious *Epimedium*, *t.* 438.

2. *Digynia.* *Buffonia*, *t.* 1313.

   Cuscuta, placed here by Linnæus, is best removed to the next class.

3. *Tetragynia.* *Ilex*, *t.* 496, a genus sometimes furnished with a few barren flowers, and therefore removed by Hudson to the twenty-third Class, of which this measure serves only to show the disadvantage; *Potamogeton*, *t.* 168, 376, and *Ruppia*, *t.* 136, are examples of this Order. They all have sessile stigmas.

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[*] See *Linn. Sp. Pl.* 186, and *Curt. Lond. fasc.* 6. *t.* 31.

CLASS 5. *Pentandria.* Stamens 5. A very large class. Orders 6.

1. *Monogynia.* One of the largest and most important Orders of the whole system. The genera are enumerated first artificially, according to the corolla being of one petal or more, or wanting; inferior or superior; with naked or covered seeds; but stand in the system according to their affinities, and compose some natural orders; as *Asperifoliæ*, rough-leaved plants, which have a monopetalous inferior corolla, and four naked seeds, with always more or less of spinous bristles or callous asperities on their foliage; see *Borago*, *Engl. Bot. t.* 36, *Lycopsis*, *t.* 938, and *Echium*, *t.* 181. Next comes that most elegant tribe of spring plants denominated *Preciæ* by Linnæus, *Primula*, *t.* 4—6, *Cyclamen*, *t.* 548, the charming alpine *Aretia*, and *Androsace*, *Curt. Mag. t.* 743. These are followed by another Linnæan order, nearly akin, called *Rotaceæ*, from the wheel-shaped corolla, *Hottonia*, *Engl. Bot. t.* 364, *Lysimachia*, *t.* 761.—*Convolvulus* and *Campanula*, two large well-known genera, come afterwards; then *Lobelia*, *t.* 140, *Impatiens*, *t.* 937, and *Viola*, *t.* 619, 620, brought hither from the abolished Linnæan order *Syngenesia Monogamia.* The *Luridæ* follow, so called from their frequently dark, gloomy aspect, indicative of their narcotic and very dangerous qualities; as *Datura*, *t.* 1288, *Hyoscyamus*, *t.* 591, *Atropa*, *t.* 592, and *Nicotiana*, or

Tobacco. In a subsequent part we meet with the Vine, Currant and Ivy, and the Order finishes with some of the natural family of *Contortæ*, so called from their oblique or twisted corolla, and which are many of them very fine plants, as *Vinca*, *t.* 514, 917. They often abound with milky juice, generally highly acrid; but Dr. Afzelius met with a shrub of this order at Sierra Leone, the milk of whose fruit was so sweet, as well as copious, as to be used instead of cream for tea. This is certainly what no one could have guessed from analogy. *Gardenia* is erroneously reckoned a *contorta* by Linnæus.

2. *Digynia* begins with the remainder of the *Contortæ*; then follow some incomplete flowers, as *Chenopodium*, *t.* 1033, *Beta*, *t.* 285, and afterwards the fine alpine genus of *Gentiana*, *t.* 20, 493, 896, famous for its extreme bitterness and consequent stomachic virtues.

The rest of the Order consists of the very natural Umbelliferous family, characterized by having five superior petals, and a pair of naked seeds, suspended vertically, when ripe, from the summit of a slender hair-like receptacle. Of the inflorescence of this tribe, and the difficulties attending their generic distinctions, we have spoken, *p.* 236. In *Eryngium*, *t.* 718 and 57, the umbel is condensed into a *capitulum*, or conical scaly head, showing an approach towards the compound flowers, and accompanied, as Jussieu observes, by the habit of a Thistle. *Lagoecia* is justly referred to this natural order by the same writer, though it has only a solitary seed and style.

The *Umbelliferæ* are mostly herbaceous; the qualities of such as grow on dry ground are aromatic, while the aquatic species are among the most deadly of poisons; according to the remark of Linnæus, who detected the cause of a dreadful disorder among horned cattle in Lapland*, in their eating young leaves of *Cicuta virosa*, *Engl. Bot. t.* 479, under water.

Botanists in general shrink from the study of the *Umbelliferæ*, nor have these plants much beauty in the eyes of amateurs; but they will repay the trouble of a careful observation. The late M. Cusson of Montpellier bestowed more pains upon them than any other botanist has ever done; but the world has, as yet, been favoured with only a part of his remarks. His labours met with a most ungrateful check, in the unkindness, and still more mortifying stupidity, of his wife, who, during his absence from home, is recorded to have destroyed his whole herbarium, scraping off the dried specimens, for the sake of the paper on which they were pasted!

3. *Trigynia* is illustrated by the Elder, the Sumach or *Rhus*, *Viburnum*, &c., also *Corrigiola*, *Engl.*

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* See his Tour in Lapland, v. 2. 136.

Bot. t. 668, and *Tamarix, t.* 1318, of which last one species, *germanica*, has ten stamens.

4. *Tetragynia* has only *Evolvulus*, nearly allied to *Convolvulus*, and the elegant and curious *Parnassia*, *t.* 82.

5. *Pentagynia* contains *Statice, t.* 226, 102, and 328, a beautiful maritime genus, with a kind of everlasting calyx. The *Flora Græca* has many fine species. *Linum* or Flax follows; also the curious exotic *Aldrovanda, Dicks. Dr. Pl.* 30; *Drosera, Engl. Bot. t.* 867—9; the numerous succulent genus *Crassula*; and the alpine *Sibbaldia, t.* 897, of the natural order of *Rosaceæ*.

6. *Polygynia. Myosurus, t.* 435, a remarkable instance of few stamens (though they often exceed five) to a multitude of pistils.

CLASS 6. *Hexandria*. Stamens 6. Orders 6.

1. *Monogynia*. This, as usual, is the most numerous. The Liliaceous family, with or without a *spatha*, called by Linnæus the nobles of the vegetable kingdom, constitute its most splendid ornament. The beautiful White Lily is commonly chosen by popular writers to exemplify the stamens and pistils. The less ostentatious genus of *Juncus* or Rush, which soon follows, is more nearly allied to the Lilies than a young botanist would suppose. Near it stand several genera which have little affinity to each other, and of these *Capura* is a mistake, having been made

out of a specimen of *Daphne indica*, which chanced to have but six stamens.

2. *Digynia* has but few genera. The valuable *Oryza*, Rice, of which there now seems to be more than one species, is the most remarkable. It is a grass with six stamens.

3. *Trigynia.* See *Rumex*, *Engl. Bot. t.* 1533, 127, &c., some species of which have separated flowers; *Tofieldia*, *t.* 536; and *Colchicum*, *t.* 133 and 1432.

4. *Tetragynia. Petiveria alliacea*, a plant the number of whose stamens is not very constant, and whose specific name is supposed to allude, not only to its garlic scent, but also to the caustic humour of the botanist whom it commemorates.

5. *Hexagynia.* An order in Schreber and Willdenow, contains *Wendlandia populifolia* of the latter; with *Damasonium* of the former, a genus consisting of the Linnæan *Stratiotes alismoides*, *Exot. Bot. t.* 15.

6. *Polygynia. Alisma* only—*Engl. Bot. t.* 837, 775, &c.

Class 7. *Heptandria.* Stamens 7. Orders 4.

1. *Monogynia. Trientalis*, *Engl. Bot. t.* 15, a favourite plant of Linnæus; and *Æsculus*, the Horse Chesnut. Several genera are removed to this order by late writers.

2. *Digynia. Limeum*, an African genus only.

3. *Tetragynia. Saururus*, a Virginian plant, *Apono-*

geton, placed here by Linnæus, is now properly removed to *Dodecandria*. It is an East Indian and Cape aquatic genus, bearing above the water white fragrant flowers in a peculiar spike, which is either solitary or double.

4. *Heptagynia*. *Septas*, a Cape plant, very nearly akin to *Crassula*, to which Thunberg refers it. If its character in Linnæus be constant with respect to number, it is very remarkable, having the calyx in seven deep segments, seven petals, seven germens, and consequently seven capsules.

CLASS 8. *Octandria*. Stamens 8. Orders 4.

1. *Monogynia*. A very various and rich order, consisting of the well-known *Tropæolum* or Nasturtium, whose original Latin name, given from the flavour of the plant, like Garden Cresses, is now become its English one in every body's mouth. The elegant and fanciful Linnæan appellation, equivalent to a *trophy plant*, alludes to its use for decorating bowers, and the resemblance of its peltate leaves to shields, as well as of its flowers to golden helmets, pierced through and through, and stained with blood. See *Linn. Hort. Cliff.* 143.—*Epilobium*, *Engl. Bot.* *t.* 838, 795, &c., with its allies, makes a beautiful part of this order; but above all are conspicuous the favourite *Fuchsia*, the chiefly American genus *Vaccinium*, *t.* 456, 319, &c.; the immense and most elegant genus *Erica*, so abundant in southern

Africa, but not known in America; and the fragrant *Daphne*, *t.* 1381, of which last the Levant possesses many charming species. *Acer*, the Maple, is removed hither in *Fl. Brit.* from the twenty-third Class.

2. *Digynia* has a few plants, but little known; among them are *Galenia africana*, and *Moehringia muscosa.*

3. *Trigynia.* *Polygonum*, *t.* 436, 509, 941, is a genus whose species differ in the number of their stamens and styles, and yet none can be more natural. Here therefore the Linnæan system claims our indulgence. *Paullinia* and *Cardiospermum* are more constant.

4. *Tetragynia.* Here we find the curious *Paris*, *t.* 7, and *Adoxa*, *t.* 453. Of the former I have lately received a new species, gathered by my liberal friend Buchanan among the mountains of Nepal.

Class 9. *Enneandria.* Stamens 9. Orders 3.

1. *Monogynia.* Of this the precious genus *Laurus*, including the Cinnamon, Bay, Sassafras, Camphor, and many other noble plants, is an example.

2. *Trigynia* has only *Rheum*, the Rhubarb, nearly related to *Rumex.*

3. *Hexagynia.* *Butomus umbellatus*, *Engl. Bot.* *t.* 651, a great ornament to our rivers and pools.

CLASS 10. *Decandria.* Stamens 10. Orders 5.

1. *Monogynia.* A numerous and fine assemblage, beginning with a tribe of flowers more or less correctly papilionaceous and leguminous, which differ very materially from the rest of that natural order in having ten stout, firm, separate stamens. See *Cassia*, *Curt. Mag. t.* 107, 633, and *Sophora*, *t.* 167; also *Exot. Bot. t.* 25—27, and *Annals of Botany*, *v.* 1. 501.

   The *Ruta*, Rue, and its allies, now become very numerous, follow. See *Tracts on Nat. Hist.* 287. *Dictamnus*, vulgarly called Fraxinella, is one of them. *Dionæa Muscipula*, see *p.* 133, stands in this artificial order, as do the beautiful *Kalmia*, *Rhododendron*, *Andromeda*, *Arbutus* and *Pyrola*, *Engl. Bot. t.* 213, &c.

2. *Digynia.* *Saxifraga*, remarkable for having the germen inferior, half inferior, and superior, in different species, a very rare example. See *Engl. Bot. t.* 167, 440, 663, 1009, 500, 501. *Dianthus*, the Pink or Carnation tribe, and some of its very distinct natural order, *Caryophylleæ*, conclude the *Decandria Digynia.*

3. *Trigynia.* The *Caryophylleæ* are here continued, as *Cucubalus*, *t.* 1577, *Silene*, *t.* 465, 1398, *Arenaria*, *t.* 189, 512, very prolific and intricate genera in the Levant. *Malpighia* and *Banisteria*, beautiful plants of the Maple family, which next occur, have no affinity to the foregoing.

4. *Pentagynia.* Abounds in more *Caryophylleæ*, as *Lychnis*, *t.* 573, and *Cerastium*, *t.* 789, 790.—*Cotyledon*, *t.* 325, *Sedum*, *t.* 1319, and *Oxalis*, *t.* 762, are placed here. Some of the last genus have the filaments united at their base, and therefore should belong to the sixteenth Class,—another defect in the artificial system.

5. *Decagynia.* Consists of only *Neurada*, with *Phytolacca*; the latter an irregular genus as to stamens and styles, which therefore afford good marks to discriminate the species.

Class 11. *Dodecandria.* Stamens 12 to 19.
Orders 6.

1. *Monogynia.* A rather numerous and very various order, with scarcely any natural affinity between the genera. Some of them have twelve, others fifteen or more stamens, which should be mentioned in their characters. *Asarum*, *Engl. Bot. t.* 1083, and the handsome *Lythrum Salicaria*, *t.* 1061, also the American Snow-drop-tree, *Halesia*, not rare in our gardens, may serve as examples of this order. *Sterculia* is very properly removed hither from *Gynandria* by Schreber and Willdenow, as its stamens are not inserted above the germen.

2. *Digynia* consists of *Heliocarpus*, a very rare American tree with a singularly fringed or radiated fruit; and *Agrimonia*, *Engl. Bot. t.* 1335. The latter

might as well have been placed in the next class, with which it agrees in natural order.

3. *Trigynia* is chiefly occupied by *Reseda*, the Mignonette, *t.* 320, 321, and *Euphorbia*, *t.* 256, 883, &c., one of the most well defined and natural genera, of which the *punicea*, *Sm. Ic. Pict. t.* 3, is a splendid exotic species.

4. *Tetragynia*, in Schreber and Willdenow, consists of *Calligonum*, a genus illustrated by L'Heritier in the *Transactions of Linn. Society*, *v.* 1; and *Aponogeton*, already mentioned, *p.* 319.

5. *Pentagynia* has *Glinus*, an insignificant genus; and *Blackwellia*, a doubtful one.

6. *Dodecagynia* is exemplified in *Sempervivum*, the Houseleek, *Engl. Bot. t.* 1320, whose styles vary from twelve to eighteen or twenty. *Sempervivum sediforme*, *Jacq. Hort. Vind. t.* 81, is a *Sedum* with a superabundance of parts in the fructification. Linnæus confounded it with *S. rupestre.*

CLASS 12. *Icosandria*. Stamens 20 or more, inserted into the Calyx. Orders 3.

1. *Monogynia* consists of fine trees, bearing for the most part stone fruits, as the Peach, Plum, Cherry, &c., though the leaves and other parts are bitter, acrid, and, as we have already mentioned, sometimes very dangerous, owing to a peculiar essential oil, known by its bitter-almond flavour. See spe-

cimens of this family in *Engl. Bot. t.* 1383, 706, 841, 842. The Myrtle tribe is another natural order, comprehended chiefly under *Icosandria Monogynia*, abounding in a fragrant and wholesome aromatic oil. These are plentiful in New Holland. See *Tr. of Linn. Soc. v.* 3. 255, also *Exot. Bot. t.* 42, 59, and 84. *Caryophyllus aromaticus*, the Clove, should on every account be removed hither.

2. *Pentagynia.* In this order it is most convenient to include such plants as have from two to five styles, and occasionally, from accidental luxuriance only, one or two more. An example of it is the very natural family of the *Pomaceæ*, as *Pyrus*, the Apple, Pear, &c. *Engl. Bot. t.* 179, 350, 337; and *Mespilus*, *t.* 1523, *Exot. Bot. t.* 18, 85. In this family some species of the same genus have five, others three, two, or only one style, and a corresponding number of seeds. *Spiræa*, nearly allied to it, stands here, most of its species having five styles, though some have a much greater number; see *Engl. Bot. t.* 284, 960. *Mesembryanthemum*, a vast and brilliant exotic genus, of a succulent habit, abounding in alkaline salt, and a few genera naturally allied to it, make up the rest of the order.

3. *Polygynia.* An entirely natural order of genuine Rosaceous flowers, except possibly *Calycanthus*. Here we find *Rosa*, *Engl. Bot. t.* 187, 990—2;

Rubus, *t.* 826, 827, 716; *Fragaria*, *t.* 1524; *Potentilla*, *t.* 88, 89, 862; *Tormentilla*, *t.* 863, 864; *Geum*, *t.* 106; *Dryas*, *t.* 451; and *Comarum*, *t.* 172: all elegant plants, agreeing in the astringent qualities of their roots, bark and foliage, and in their generally eatable, always innocent, fruit. The vegetable kingdom does not afford a more satisfactory example of a natural order, composed of natural genera, than this; and Linnæus has well illustrated it in the *Flora Lapponica*. His genus *Tormentilla*, differing from *Potentilla* in number of petals and segments of the calyx, though retained by Jussieu, may perhaps be scarcely distinct; yet there is a difference in their habit, which has induced me to leave it for further consideration. Haller united them both with *Fragaria* and *Comarum*, which the character and habit of the latter totally forbid, and Gærtner has well suggested a mark from the smoothness of the seeds in *Fragaria*, (as well as *Comarum*,) to strengthen that of its pulpy receptacle. Whatever difficulties may attend these genera, how admirably does the fruit serve us in *Rosa*, *Rubus*, *Dryas* and *Geum*, to discriminate those whose leaves, flowers, and habit all stamp them as distinct! A student cannot do better than to study this order and these genera, as an introduction to the knowledge of more obscure ones; and the beautiful plants which compose it, mostly familiar to every body, are easily obtained.

CLASS 13. *Polyandria.* Stamens numerous, inserted into the Receptacle. Orders 7.

1. *Monogynia.* The genera of this order are artificially distributed according to the number of their petals, but not so arranged in the body of the system. They form a numerous and various assemblage of handsome plants, but many are of a suspected quality. Among them are the Poppy, the Caper-shrub, the *Sanguinaria canadensis*, *Curt. Mag. t.* 162, remarkable for its orange juice, like our Celandine, *Engl. Bot. t.* 1581; also the beautiful genus *Cistus*, with its copious but short-lived flowers, some of which (*Engl. Bot. t.* 1321) have irritable stamens; the splendid aquatic tribe of *Nymphæa*, &c., *t.* 159, 160, 2292. But the precious Nutmeg and the Tea* are perhaps erroneously placed here by Linnæus, as well as the Clove; while on the other hand *Cleome* more properly belongs to this part of the system than to the fifteenth Class.

2. *Digynia* has principally the *Pæonia*, *t.* 1513, variable in number of pistils, and *Fothergilla alnifolia*, an American shrub.

3. *Trigynia. Delphinium* the Larkspur, and *Aconitum* the Monk's hood, two variable and uncertain genera as to number of pistils.

4. *Tetragynia. Tetracera* ought, by its name, to have constantly four pistils, but the rest of this order

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* See *Monadelphia.*

are very doubtful. *Caryocar*, whose large rugged woody nuts contain the most exquisite kernel ever brought to our tables, and which is the same plant with Gærtner's and Schreber's *Rhizobolus*, as the excellent Willdenow rightly judged, is not certain in number; and still less the *Cimicifuga*; whilst *Wahlbomia* is probably a *Tetracera*: see Willdenow.

5. *Pentagynia* contains chiefly *Aquilegia* the Columbine, and *Nigella*—both strictly allied to genera in the third order. *Reaumuria* indeed is here well placed. Some *Nigellæ* have ten styles.

6. *Hexagynia* consists of *Stratiotes*, *Engl. Bot. t.* 379; and *Brasenia*, a new genus of Schreber's with which I am not acquainted.

I would recommend an union of the last five orders, for the same reason that influenced me in the preceding class. They now only serve to keep natural genera asunder, the species of which not only differ among themselves as to number of pistils, but each species is often variable besides. The genera are so few that no inconvenience could arise on that account. I conceive such reforms, founded in experience not in theory, serve to strengthen the system, by greatly facilitating its application to practice.

7. *Polygynia.* An order for the most part natural, comprehending some fine exotic trees, as *Dillenia*, *Exot. Bot. t.* 2, 3, 92 and 93; *Liriodendron*, the Tulip-tree; the noble *Magnolia*, &c.; a tribe con-

cerning whose genera our periodical writers are falling into great mistakes. To these succeed a family of plants, either herbaceous or climbing, of great elegance, but of acrid and dangerous qualities, as *Anemone*, in a single state the most lovely, in a double one the most splendid, ornament of our parterres in the spring; *Atragene* and *Clematis*, so graceful for bowers; *Thalictrum*, *Adonis*, *Ranunculus*, *Trollius*, *Helleborus* and *Caltha*, all conspicuous in our gardens or meadows, which, with a few less familiar, close this class.

Nothing can be more injudicious than uniting these two last classes, as some inexperienced authors have done. They are immutably distinct in nature and characters, whether we call the part which immediately bears the stamens in the *Icosandria* a calyx, with most botanists, or a receptacle, with Mr. Salisbury in the eighth volume of the Linnæan Society's Transactions, where, among many things which I wish had been omitted, are some good remarks concerning the distinction between calyx and corolla. This the writer in question considers as decided in doubtful cases by the latter sometimes bearing the stamens, which the former, in his opinion, never really does.

CLASS 14. *Didynamia*. Stamens 2 long and 2 short. Orders 2, each on the whole very natural.

1. *Gymnospermia*. Seeds naked, in the bottom of

the calyx, four, except in *Phryma*, which has a solitary seed.—Corolla monopetalous and irregular, a little inflated at the base, and holding honey, without any particular nectary. Stamens in two pairs, incurved, with the style between them, so that the impregnation rarely fails. The plants of this order are mostly aromatic, and none, I believe, poisonous. The calyx is either in five nearly equal segments, or two-lipped. Most of the genera afford excellent essential characters, taken frequently from the corolla, or from some other part. Thus,

Perilla has two styles, of which it is an unique example in this class.

Mentha a corolla whose segments are nearly equal, and spreading stamens. *Engl. Bot. t.* 446—8.

Lavandula the Lavender, and *Westringia*, *Tracts on Natural History*, 277, *t.* 3, have a *corolla resupinata*, reversed, or laid on its back.

Teucrium a deeply divided upper lip, allowing the stamens and style to project between its lobes. *Engl. Bot. t.* 680.

Ajuga scarcely any upper lip at all, *t.* 77 and 489.

Lamium has the mouth toothed on each side, *t.* 768.

Prunella, *t.* 961, has forked filaments; *Cleonia* four stigmas; *Prasium* a pulpy coat to its seeds. These instances will suffice as clear examples of natural genera, distinguished by an essential technical character, in a most natural order.

2. *Angiospermia.* Seeds in a capsule, and generally very numerous.—The plants of this order have the greatest possible affinity with some families in *Pentandria Monogynia.* Some species even vary from one class to the other, as *Bignonia radicans, Curt. Mag. t.* 485, and *Antirrhinum Linaria, Engl. Bot. t.* 658, 260; in which the irregular corolla becomes regular, and the four unequal stamens are changed to five equal ones; nor does this depend, as has been asserted, on the action of any extraneous pollen upon the stigmas of the parent plant, neither are the seeds always abortive. No method of arrangement, natural or artificial, could provide against such anomalies as these, and therefore imperfections must be expected in every system.

CLASS 15. *Tetradynamia.* Stamens 4 long and 2 short. Orders 2, perfectly natural. Flowers cruciform.

1. *Siliculosa.* Fruit a roundish pod, or pouch. In some genera it is entire, as *Draba, Engl. Bot. t.* 586, and the Honesty or Satin flower, *Lunaria:* in others notched, as *Thlaspi, t.* 1659, and *Iberis, t.* 52; which last genus is unique in its natural order in having unequal petals. *Crambe, t.* 924; *Isatis, t.* 97; and *Bunias, t.* 231; certainly belong to this Order, though placed by Linnæus in the next.

2. *Siliquosa.* Fruit a very long pod. Some genera have a *calyx clausus,* its leaves slightly cohering by

their sides, as *Raphanus*, *t.* 856; *Cheiranthus*, *t.* 462; *Hesperis*, *t.* 731; *Brassica*, *t.* 637, &c. Others have a spreading or gaping calyx, as *Cardamine*, *t.* 1000; *Sisymbrium*, *t.* 855; and especially *Sinapis*, *t.* 969 and *t.* 1677.

Cleome is a very irregular genus, allied in habit, and even in the number of stamens of several species, to the *Polyandria Monogynia*. Its fruit, moreover, is a capsule of one cell, not the real two-celled pod of this Order. Most of its species are fœtid and very poisonous, whereas scarcely any plants properly belonging to this Class are remarkably noxious, for I have great doubts concerning the disease called *Raphania*, attributed by Linnæus to the seeds of *Raphanus Raphanistrum*.

The Cruciform plants are vulgarly called antiscorbutic, and supposed to be of an alkalescent nature. Their essential oil, which is generally obtainable in very small quantities by distillation, smells like volatile alkali, and is of a very acrid quality. Hence the fœtid scent of water in which cabbages, or other plants of this tribe, have been boiled.

Class 16. *Monadelphia*. Stamens united by their filaments into one tube. Orders 8, distinguished by the number of their stamens.

1. *Triandria* is exemplified by *Sisyrinchium*, *Ic. Pict.* *t.* 9, and *Ferraria*, *Curt. Mag.* *t.* 144, 532, both erroneously placed by Linnæus in *Gynandria*. Also

the singular Cape plant *Aphyteia*, consisting of a large flower and succulent fruit, springing immediately from the root, without stem or leaves. On this plant Linnæus published a dissertation in 1775. *Tamarindus* has lately been removed hither from the third Class, perhaps justly.

2. *Pentandria*. *Erodium*, *Engl. Bot. t.* 902, separated, with great propriety, from *Geranium* by L'Heritier; *Hermannia*, a pretty Cape genus, *Curt. Mag. t.* 307; and a few other plants, more or less akin to the Mallow tribe, compose this Order; to which also strictly belong some species of *Linum*, *Geranium*, &c. *Passiflora*, removed from *Gynandria*, belongs most unquestionably to *Pentandria Trigynia*, and by no means to this Class.

3. *Heptandria* consists only of *Pelargonium* of L'Heritier, an excellent genus, comprising most of the Cape Geraniums, and marked by its irregular flower, seven stamens, and tubular nectary.

4. *Octandria* contains *Aitonia*, *Curt. Mag. t.* 173, named in honour of the excellent and universally respected author of the *Hortus Kewensis*. *Pistia* is, I believe justly, placed here by Schreber and Willdenow.

5. *Decandria*. *Geranium*, properly so called, *Engl. Bot. t.* 404, 405, 272, &c., is the principal genus here. The late Professor Cavanilles, however, in his *Dissertationes Botanicæ*, referred to this Order

a vast number of genera, never before suspected to belong to it, as *Bannisteria*, *Malpighia*, *Turræa*, *Melia*, &c., on account of some fancied union of their filaments, perhaps through the medium of a tubular nectary; which principle is absolutely inadmissible; for we might just as well refer to *Monadelphia* every plant whose filaments are connected by insertion into a tubular corolla. Some species of *Oxalis*, see *p.* 323, belong to this Order; as do several papilionaceous genera, of which we shall speak under the next Class.

6. *Endecandria* contains only the splendid South-American genus *Brownea*, the number of whose stamens is different in different species.

7. *Dodecandria*, Stamens mostly fifteen, is composed of some fine plants allied to the Mallows, as *Pterospermum*, *Curt. Mag. t.* 620, *Pentapetes*, &c.

8. *Polyandria*, a very numerous and magnificent Order, comprises, among other things, the true *Columniferæ* or *Malvaceæ*, as *Malva*, *Engl. Bot. t.* 671, 754, *Althæa*, *t.* 147, *Hibiscus*, *Spicil. Bot. t.* 8, *Gossypium* the Cotton-tree, *Alcea* the Hollyhock, &c. Stately and beautiful plants of this Order, though not *Malvaceæ*, are *Carolinea*, whose angular seeds are sold in our shops by the name of Brasil nuts; *Gustavia*, named after the late King of Sweden, a great patron of botany and of Linnæus; *Camellia*, *Curt. Mag. t.* 42, whose splendid va-

rieties have of late become favourites with collectors; *Thea*, the Tea-tree, its near relation, placed by Linnæus in *Polyandria Monogynia**; *Stuartia*, *Exot. Bot. t.* 110; and *Barringtonia*, the original *Commersonia*, *Sonnerat Voy. à la Nouv. Guinée*, *t.* 8, 9.

Class 17. *Diadelphia.* Stamens united by their filaments into two parcels, both sometimes cohering at the base. Orders 4, distinguished by the number of their Stamens. Flowers almost universally papilionaceous.

1. *Pentandria.* The only genus in this Order is *Monnieria*, *Lamarck t.* 596, a rare little South American plant, whose natural order is uncertain. It has a ringent corolla, ternate leaves, a simple bristly pubescence, and is besprinkled with resinous dots.

2. *Hexandria.* *Saraca*, in this Order, is as little known as the *Monnieria*, except that it undoubtedly belongs to the leguminous family. It seems most allied to *Brownea*, *Jonesia*, *Afzelia*, &c. *Fumaria*, the only genus besides, is remarkable for the great variety of forms in its seed-vessel, whence botanists who make genera from technical characters, without regard to natural principles, have injudiciously sub-

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* The observations of Dr. Kendrick, of Warrington, have determined the class of this interesting plant, much to our satisfaction.

divided it. See *Engl. Bot. t.* 588—590, 943, 1471.

3. *Octandria. Polygala, t.* 76, is the principal genus here. America and the Cape of Good Hope abound in beautiful species of it, and New Holland affords some new genera, long confounded with this. *Dalbergia* is perhaps as well placed in the next Order.

4. *Decandria* is by far the most numerous, as well as natural, Order of this Class, consequently the genera are difficult to characterize. They compose the family of proper *Papilionaceæ* or *Leguminosæ*, the Pea, Vetch, Broom, &c. Their stamens are most usually nine in one set, with a single one separate.

The genera are arranged in sections variously characterized.

* *Stamens all united*, that is, all in one set. The plants of this section are really not *diadelphous* but *monadelphous*. See *Spartium, Engl. Bot. t.* 1339. Some of them, as *Lupinus*, and *Ulex, t.* 742, 743, have indeed the tenth stamen evidently distinguished from the rest, though incorporated with them by its lower part. Others have a longitudinal slit in the upper side of the tube, or the latter easily separates there, as *Ononis, t.* 682, without any indication of a separate stamen. Here therefore the Linnæan System swerves from its strict artificial laws, in compliance with the decisive natural character which marks the plants in question. We easily perceive that character,

and have only to ascertain whether any papilionaceous plant we may have to examine has ten stamens, all alike separate and distinct, in which case it belongs to the tenth Class, or whether they are in any way combined, which refers it to the seventeenth.

** *Stigma downy*, without the character of the preceding section, for this and all the following are truly diadelphous. Very nice, but accurate, marks distinguish the genera, which are sufficiently natural. The style and stigma afford the discriminative characteristics of *Orobus*, *t.* 1153; *Pisum*, *t.* 1046; *Lathyrus*, *t.* 670, 1108; *Vicia*, *t.* 334, 481—483; and no less decisively in *Ervum*, *t.* 970, 1223, which last genus, notwithstanding the remark in Jussieu 360, "*stigma non barbatum*," (taken probably from no genuine species,) most evidently belongs to this section, as was first remarked in the *Flora Britannica*; and it is clearly distinguished from all the other genera of the section by the *capitate stigma hairy all over*; nor is any genus in the whole Class more natural, when the hitherto mistaken species are removed to their proper places. See *Fl. Brit.*

*** *Legume imperfectly divided into two cells*, always, as in all the following, without the character of the preceding sections. This is composed of the singular *Biserrula*, known by its doubly serrated fruit, of which there is only one species; the *Phaca*, *Jacq. Ic. Rar. t.* 151; and the vast genus of *Astragalus*, *Engl. Bot. t.* 274, &c., lately illustrated in a splendid work by an able French botanist, Decandolle.

**** *Legume with scarcely more than one seed.* Of this *Psoralea, Curt. Mag. t.* 665; the curious *Stylosanthes* of Swartz; the *Hallia* of Thunberg; and our own *Trifolium, Engl. Bot. t.* 1770, 1048—1050, are examples. The last genus, one of the most natural as to habit and qualities, is extremely untractable with respect to botanical characters. Some species, *t.* 1047, 1340, 1769, have many seeds in each pod; some have not even the capitate inflorescence, made a part of the generic definition. The difficulty is lessened by establishing *Melilotus* as a genus, with Jussieu: but the whole requires to be well reconsidered; for, if possible, so great a laxity of definition, with such glaring exceptions, should not disgrace any system.

***** *Legume composed of single-valved joints, which are rarely solitary. Hedysarum, t.* 96, is the most important genus of this section, and is known by its obtuse or rectangular keel. *Hippocrepis, t.* 31; *Ornithopus, t.* 369; and *Scorpiurus*, known in gardens by the name of Caterpillar, from its worm-like pod, are further examples. *Smithia, Ait. Hort. Kew. t.* 18, is remarkable for having the joints of the legume connected by means of the style, as by a thread; the stamens in two equal divisions, with five anthers to each; and a two-lipped calyx. *Hedysarum vespertilionis, Jacq. Ic. Rar. t.* 566, in some points approaches this genus, and more certain species are possibly latent among the numerous unsettled papilionaceous plants of India.

****** *Legume of one cell, with several seeds.* To this belong the genus *Melilotus*, if separated from *Trifolium*; the *Indigofera*, several species of which are so valuable for dyeing blue; the handsome *Robinia*, *Curt. Mag. t.* 311; *Cytisus, t.* 176, &c.; and *Clitoria**, *Ins. of Georgia, t.* 18: also *Lotus*, *Engl. Bot. t.* 925, and *Medicago, t.* 1616; which last is justly transferred by Willdenow from the foregoing section to this.

Papilionaceous plants are rarely noxious to the larger tribes of animals, though some species of *Galega* intoxicate fish. The seeds of *Cytisus Laburnum* have of late been found violently emetic, and those of *Lathyrus sativus* have been supposed at Florence to soften the bones, and cause death; we know of no other similar instances in this Class, which is one of the most abundant in valuable esculent plants. The Negroes have a notion that the beautiful little scarlet and black seeds of *Abrus precatorius*, so frequently used for necklaces, are extremely poisonous, insomuch that half of one is sufficient to kill a man. This is totally incredible. Linnæus however asserts rather too absolutely, that "among all the leguminous or papilionaceous tribe there is no deleterious plant to be found.”

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* From κλειω, to close or shut up, in allusion to the situation of the wings and keel.

Class 18. *Polyadelphia.* Stamens united by their filaments into more than two parcels. Orders three, distinguished by the number or insertion of their stamens, which last particular Linnæus here overlooked.

No part of the Linnæan system has been less accurately defined or understood than the Orders of the eighteenth Class. Willdenow, aware of this, has made some improvements, but they appear to me not sufficient, and I venture to propose the following arrangement.

1. *Dodecandria.* Stamens, or rather Anthers, from twelve to twenty, or twenty-five, their filaments unconnected with the calyx. Of this the first example that presents itself is *Theobroma*, the Chocolate tree, *Merian. Surin. t.* 26, 63, *Lamarck Illustr. t.* 635. The flowers have not been seen fresh in Europe, and we only know them from drawings made in the West Indies, one of which, preserved in the Linnæan herbarium, is my authority for the following descriptions. The filaments are inserted between the long tapering segments of a five-cleft nectary, on its outside, and each bears at its summit four sessile, obtuse, spreading anthers. Aublet’s figure of this genus, which Schreber and Willdenow seem to have followed, represents but two. The

fruit is perhaps most properly a berry with a hard coat, whose seeds, when roasted, make chocolate. *Bubroma* of Schreber, *Guazuma Lamarck, t.* 637, confounded by Linnæus with the preceding genus, has similar filaments, but each bears five anthers; Jussieu and Cavanilles say three. The fruit is a woody capsule, with ten rows of perforations. *Abroma, Jacq. Hort. Vind. v.* 3. *t.* 1. *Miller Illustr. t.* 63, has five parcels of anthers, nearly sessile on the outside of the nectary, between its obtuse, reflexed, notched lobes. It is difficult to say how many anthers compose each parcel, for the different accounts on record are totally irreconcileable. We have found three; the drawing sent to Linnæus represents six; and Miller has a much greater number. Perhaps they may vary. In this uncertainty the genus in question is best placed with its natural allies in this order, with a reference to it in italics at the end of *Polyadelphia Polyandria.* Its fruit is a membranous winged capsule, opening at the top. *Monsonia, Curt. Mag. t.* 73, *Lamarck t.* 638, removed by Schreber and Willdenow to *Monadelphia*, rather, I think, belongs to this class, where Linnæus placed it. The five filaments, bearing each three long-stalked anthers, are merely inserted into a short membranous cup, or nectary, for so the analogy of the three preceding genera induces us to call it; and if we refer *Monsonia* to *Monadelphia*, we fall into the error of Cavanilles mentioned *p.* 333. Lastly, *Citrus*, the Orange, Lemon, &c., *Lamarck t.* 639, most unquestionably belongs to this Order. Its stamens are about nineteen or twenty, combined variously and unequally in several distinct parcels; but those parcels are inserted into a proper receptacle, by no means into the calyx, as the character of the Class *Icosandria* indispensably requires. Even the number of the anthers of *Citrus* accords better with most plants in *Dodecandria* than in *Icosandria*, notwithstanding the title of the latter.

2. *Icosandria*. Stamens numerous, their filaments inserted (in several parcels) into the calyx.—To this Order Professor Willdenow properly refers *Melaleuca*, *Exot. Bot. t.* 34—36, 55, 56, which had previously stood in *Polyandria*, botanists having only considered *number* and not *insertion* in the Orders of *Polyadelphia*, whence a double mistake has arisen, concerning *Citrus* on the one hand, and *Melaleuca* on the other.

3. *Polyandria*. Stamens very numerous, unconnected with the calyx. This Order consists of several genera. The most remarkable is *Hypericum*, *Engl. Bot. t.* 109, 1225—1227, &c., whose stamens are united into three or five parcels, corresponding with the number of its styles. *Munchhausia* is a *Lagerstromia*, nor does it appear to be polyadelphous at all. Linnæus seems to have intended bringing *Thea* into this Order; see *Monadelphia Polyandria*.

CLASS 19. *Syngenesia*. Anthers united into a tube. Flowers compound. Orders 5.

This being truly a natural Class, its Orders are most of them equally so, though some are liable to exceptions, as will presently be explained.

1. *Polygamia æqualis*. In this each floret, taken separately, is perfect or united, being furnished with its own perfect stamens and pistil, and capable of bringing its seed to maturity without the assistance of any other floret. The Order consists of three sections.

* *Florets all ligulate, or strap-shaped,* called by Tournefort *semiflosculous*. These flowers are generally yellow, sometimes blue, very rarely reddish. They expand in a morning, and close towards noon or in cloudy weather. Their herbage is commonly milky and bitter. *Leontodon, Engl. Bot. t.* 510; *Tragopogon, t.* 434, 638; *Hieracium, t.* 349, &c.; and *Cichorium, t.* 539, exemplify this very natural section.

** *Flowers globose, generally uniform and regular, their florets all tubular, five-cleft, and spreading. Carduus, t.* 675, 973, 976; *Onopordum, t.* 977; and *Arctium, t.* 1228, well exemplify this. *Carlina, t.* 1144, does not so exactly agree with the above definition, having a flat disk; but its affinity to the other genera is indubitable. Its flattened disk and radiating coloured calyx seem contrived to imitate the radiated flowers of the following Order.

*** *Flowers discoid, their florets all tubular, regular, crowded and parallel, forming a surface nearly flat, or exactly conical.* Their colour is most generally yellow, in some cases pink. *Santolina, t.* 141; and *Bidens, t.* 1113, 1114, are genuine examples of this section: *Eupatorium, t.* 428, and the exotic *Stæhelina, Dicks. Dr. Pl.* 13, approach to the preceding one. There is however the most absolute difference between these two sections, collectively, and the first; while, on the other hand, they have considerable affinity with some of the following Orders, as will be hereafter explained.

2. *Polygamia superflua.* Florets of the disk perfect or united; those of the margin furnished with pistils only; but all producing perfect seed.

* *Discoid,* the florets of the margin being obsolete or inconspicuous, from the smallness or peculiar form of the corolla; as *Artemisia, Engl. Bot. t.* 338, 978, 1230; *Tanacetum, t.* 1229; *Conyza, t.* 1195; and *Gnaphalium, t.* 267, 1157. In the last the marginal florets are mostly five-cleft and tubular like the rest, only wanting stamens. Caution is requisite to detect the difference between this section and the preceding Order.

** *Ligulate, two-lipped,* of which *Perdicium,* a rare exotic genus, is the only instance.

*** *Radiant,* the marginal florets ligulate, forming spreading conspicuous rays; as *Bellis* the Daisy, *t.* 424;

Aster, *t.* 87, a very numerous genus in America; *Chrysanthemum*, *t.* 601, 540; *Inula*, *t.* 1546, &c. This section seems, at first sight, a combination of the first and third sections of the former Order, but this is chiefly in the form of its corollas. It is rather an approach of that third section towards what is equivalent to becoming double in other tribes. Accordingly, the Chamomile, *Anthemis nobilis*, *t.* 980; *Chrysanthemum Leucanthemum*, *t.* 601; and some others, occasionally have their whole disk changed to ligulate white florets, destitute of stamens, and consequently abortive. Such are actually called double flowers in this Class, and very properly. Many exotic species so circumstanced are met with in gardens. A few very strange anomalies occur in this section, as already mentioned, *p.* 233, one *Sigesbeckia* having but three stamens, instead of five, the otherwise universal number in the Class; and *Tussilago hybrida*, *t.* 430, as well as *paradoxa* of Retzius, having distinct anthers. Nature therefore, even in this most natural Class, is not quite without exceptions.

3. *Polygamia frustranea.* Florets of the disk, as in the preceding, perfect or united; those of the margin neuter, or destitute of pistils as well as of stamens; only some few genera having the rudiments of pistils in their radiant florets.

This Order is, still more evidently than the last, analogous to double flowers of other Classes. Accordingly, *Coreopsis* is the very same genus as *Bidens*, only furnished with unproductive radiant florets. *C. bidens* of Linnæus is the same species as his *B. cernua*; *C. coronata* is his *B. frondosa*; and *C. leucantha*, *B. pilosa*. Some species of *Coreopsis* indeed have never been found without rays. Linnæus expresses his difficulties on this subject in *Phil. Bot. sect.* 209, but seems inclined to unite the two genera. A similar ambiguity occurs between *Gorteria* and *Atractylis*, *Relhania* (of the last Order) and *Athanasia*, and in some degree between *Centaurea*, *Engl. Bot. t.* 278, 1678, 56, &c., and *Carduus*, or *Serratula*; only the scales of the calyx of *Centaurea* generally keep that genus distinct.

I should be much inclined to abolish this Order. Those of its genera which have rudiments of pistils in their radiant florets, as *Rudbeckia* and *Helianthus*, would very commodiously range with their near relations in *Polygamia superflua*, nor are we sure that such radiant florets are in all circumstances abortive, neither can a student often know whether they are so or not. It does not follow, from what has just been observed, that the presence of radiant florets, whether abortive or not, can never afford a generic character, provided there be no corresponding genus without them. This must be determined by experience and observation. They are indeed to be considered as a very secondary mark, the most essential in this Class being derived from the receptacle, crown of the seed, and calyx. These Gærtner has illustrated with the greatest accuracy and skill, but even these must not be blindly followed to the destruction of natural genera.

4. *Polygamia necessaria.* Florets of the disk furnished with stamens only; those of the margin, or radius, only with pistils; so that both are necessary to each other. This is well seen in the common Garden Marigold, *Calendula*, in whose calyx, when ripening seed, the naked and barren disk is conspicuous. *Othonna*, *Curt. Mag. t.* 306, 768, *Arctotis*, *Osteospermum* and *Silphium*, not rare in gardens, are further examples of this Order, which I believe is constant and founded in nature. We have no British specimens either of it or the following. *Filago*, at least as far as our *Flora* is concerned, belongs to *Gnaphalium*. See *Engl. Bot. t.* 946, 1193, &c.

5. *Polygamia segregata.* Several flowers, either simple or compound, but with united tubular anthers, and with a partial calyx, all included in one general calyx. Of these the Globe-thistle, *Echinops*, and *Stoebe*, with *Seriphium* and *Corymbium*, (which two last require to be removed hither from the abolished Linnæan Order *Syngenesia Monogamia*,) have only one floret in each partial calyx; *Jungia* has three, *Elephantopus* four, others more. In

every case the partial calyx is distinguished from the chaffy seed-crown observable in several genera of the other Orders, (though the latter is indeed analogous to a calyx,) either by being inferior, or by the presence of a seed-crown, or feathery down, besides. See *Lamarck*, *t.* 718—723, where the plants in question are well represented.

CLASS 20. *Gynandria.* Stamens inserted either upon the style or germen. Orders 9 in Linnæus, but some alterations concerning them are necessary.

This is one of those Classes abolished by the celebrated Thunberg, and by several less intelligent writers who have followed him. The reasons which led to this measure appear to have been, that Linnæus has erroneously placed in *Gynandria* several plants which have not the requisite character; hence that character itself has been judged ambiguous, or not founded in nature, and the system has been supposed to be simplified by overlooking it. This appears to me a great mistake. The character of the Class, taken as above, is as evident, constant and genuine as that of any other in the system. No doubt can arise, if we be careful to observe that the stamens actually grow out of the germen or style, and not merely out of any part that supports the germen; as will appear by examples.

1. *Monandria.* Stamen, or sessile Anther, one only. This contains all the beautiful and curious natural family of the *Orchideæ*, or Orchis tribe, except only

Cypripedium, which belongs to the next Order. I am induced to consider the bulk of this family as *monandrous*, upon a careful review of Professor Swartz's representation of the subject, in his excellent treatise, just come to my hands in English. See *Tracts relative to Botany translated from different Languages* (by Mr. König), printed for Phillips and Fardon, 1805. I have already, *p.* 207, mentioned the glutinous nature of the pollen of these plants. This forms yellow elastic masses, often stalked, in each cell of the anther, and the cells are either parallel and close together, or removed from each other to the opposite sides of the style: which serves to connect them, just as the filament does in many Scitamineous plants, alike therefore decided to be monandrous. Such a decision with regard to those also is justified by the analogy of other species, whose cells being approximated or conjoined, properly constitute but one anther. The grand and absolute subdivision of the *Orchideæ* is justly founded by Dr. Swartz, after Haller, on the structure of the anther, whether it be, as just described, *parallel*, like that of *Orchis*, *Engl. Bot. t.* 22; *Ophrys*, *t.* 65; and *Diuris*, *Exot. Bot. t.* 9, &c.; or *vertical*, consisting of a moveable lid on the top of the style, like *Dendrobium*, *t.* 10—12; or *Malaxis*, *Engl. Bot. t.* 72. The style of the *Orchideæ* has been called a column, but I think that term now altogether superfluous. It is really a style, and the stigma is a moist shining space, generally concave, and situated, for the most part, in front of the style beneath the anther. In *Orchis bifolia*, *t.* 22, and others, it is just above the orifice of the spur. Concerning the nectary of these plants there has been much diversity of opinion. The *calcar*, spur, in *Orchis*, and some other genera, is acknowledged to be such, and holds abundance of honey. This spur is judged by Swartz, as well as Linnæus, a decisive generic mark of distinction, and it commonly is so; but some Indian species brought by Dr. Buchanan prove it not to be absolute. The remarkable and often highly ornamented lip, considered by Swartz as the only corolla, for he takes all the other leaves of the flower for a calyx, has, by Linnæus and others, been thought, either a part of the nectary, or, where no spur is present, the only nectary. Nor is this opinion so ill-founded as many botanists suppose; for the front of the lip evidently secretes honey in *Ophrys* (or *Epipactis*) *ovata*, *t.* 1548, and probably in others not yet attended to. Nevertheless, this lip might, like the petals of lilies, be deemed a nectariferous corolla, were it certain that all the other leaves were truly a calyx. But the two inner are so remarkably different from the three outer ones in *Ophrys*, *t.* 64, 65, 71, 383, and above all in *Stelis*, *Exot. Bot. t.* 75, that I am most inclined to take the former for the corolla, the latter being, according to all appearance, a calyx. An insensible gradation from one to the other, of which we have pointed out other instances in treating of this subject already, occurs in *Diuris*, *t.* 8, 9; while in some *Orchideæ* the leaves all partake more of the habit of a calyx, and in others of a corolla. Even the lip in *Thelymitra*, *t.* 29, assumes the exact form, colour, and texture, of the rest of the flower; which proves that a dissimilarity between any of these parts is not always to be expected in the family under consideration. *Vahl* appears by the preface to his *Enumeratio Plantarum* to have removed the *Scitamineæ* to *Gynandria*, because the stamen of *Canna* adheres to the style. This, if constant, could only concern that genus, for the rest of the Order are in so sense gynandrous.

2. *Diandria*. To this Order *Cypripedium*, *Engl. Bot. t.* 1, must be referred, having a pair of very distinct double-celled anthers. See *Tr. of Linn. Soc. v.* 1. *t.* 2, 3. Here we find *Forstera*, so well illustrated by Professor Swartz in Sims and König's *Annals of Botany*, *v.* 1. 291, *t.* 6; of which genus *Phyllachne*, *t.* 5 of the same volume, is justly there reckoned a species. Of the same natural order with *Forstera* is *Stylidium*; but that having, I think, four anthers, belongs to the fourth Order of the present Class. *Gunnera*, placed by Linnæus in *Gynandria Diandria*, is not yet sufficiently well understood.

3. *Triandria.* *Salacia*, if Linnæus's description be right, is properly placed here; but Jussieu doubts it, nor does my dried specimen serve to remove the uncertainty. *Stilago* proves to be merely the barren plant of *Antidesma alexiteria*, and belongs to *Dioecia*; as *Sisyrinchium* and *Ferraria* do to *Monadelphia*, the tubular united stamens of the two last having been mistaken for a solid style. *Rhopium* of Schreber (*Meborea* of *Aublet*, *t.* 323,) seems therefore the only certain genus of the Order under consideration; unless Lamarck be right in referring to it Jacquin's *Strumpfia*, upon which I have not materials to form any opinion. The original discoverer attributes to this plant five stamens with united anthers; hence it found a place in the *Syngenesia Monogamia* of Linnæus. Lamarck merits attention, as he appears to have had an authentic specimen. See his *t.* 731.

4. *Tetrandria.* *Nepenthes*, of whose extraordinary kind of leaf mention is made *p.* 150, is the only genus of this Order in Linnæus, but very erroneously placed here, for it belongs to *Dioecia Monadelphia.* The Order however must be retained for the sake of *Stylidium*, a New Holland genus, related, as above mentioned, to *Forstera*. This is my *Ventenatia*, *Exot. Bot. t.* 66, 67; but another genus having previously, without my knowledge, received the latter denomination, that of *Stylidium*, under

which I had, some time ago, communicated this genus to the French botanists*, and which they have adopted, becomes established. See Labillardiere's excellent work on New Holland plants, where several species of it are figured.

5. *Pentandria.* The original genera of this Order, *Ayenia*, *Gluta*, and *Passiflora*, *Exot. Bot. t.* 28, most unquestionably have nothing to do with it, their stamens being inserted below the germen, merely on a columnar receptacle. The learned Schreber therefore removed them to the fifth Class.

It has been thought that this Order might receive a reinforcement from the Linnæan *Pentandria Digynia.* Several of the *Contortæ* have long been suspected to belong to *Gynandria*; see *Pergularia*, *Ic. Pict. t.* 16, and *Andr. Repos. t.* 184. In this genus, as well as *Cynanchum* and *Asclepias*, the pollen appears in five pair of glutinous masses, exactly like the pollen of *Orchideæ*, sticking upon the stigma. Each mass of pollen is received into a bag, or cell, formed by a valvular apparatus that encircles the organs of impregnation, like the generality of stamens. The pollen however is, in the above genera, not found attached to these cells or valves, but to five glands, each of which is double, and all of them seated on that thick abrupt angular body which acts as a stigma *. Nor is it worth while to dispute whether this whole body be a stigma or not, with regard to the question under consideration, for it is borne by the styles, above the germen, and itself bears the anthers. I humbly conceive, however, with Linnæus and Jacquin, that as part of it, at least, receives the pollen, stigma is full as good a name for this body as Haller's term *dolium*, a tub! Still less is it worth while to controvert with Kölreuter the propriety of the term pollen, because the substance in question is not actually a dry powder, any more than in the Orchis tribe, or in *Mirabilis*, *Exot. Bot. t.* 23. That term is technically used for the matter which renders the seeds fertile, including its vehicle, whether the latter be capsular or glutinous, in short, whatever the appearance or texture of the whole may be. Another question remains, more immediately to our present purpose, whether these plants have five stamens or ten? Jacquin, who has well illustrated several of them in his *Miscell. Austr. v.* 1. *t.* 1—4, and Rottböll in a dissertation on the subject, contend for the latter. Rottböll wrote to Haller, that "finding Linnæus deaf to all that had been said, he sent him his treatise, to see whether he would persist in falsifying nature." Thus sordid underlings foment the animosities and flatter the failings of their superiors! Linnæus judiciously suspended his opinion, and, after all, proves to be most correct. The analogies of the *Orchideæ* and *Scitamineæ* very clearly decide that the two cells, or the double masses of naked pollen, can only be considered as one anther of two lobes. *Periploca græca* confirms this. Each lobe of its anthers stands, as in many *Scitamineæ*, on the outermost edge of the filament; thus meeting that on the adjoining filament, and in appearance constituting with it a two-lobed anther, as the lobe of the *Scitamineæ*, where there is but one filament, meets its corresponding lobe by embracing the style.

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* I was not aware of Loureiro's *Stylidium*, a plant, according to his description, of the seventh Class; *Fl. Cochinch. v.* 1. 221; but this can scarcely interfere with ours, being probably, as it grows about Canton, some well-known shrub that happened to have a seven-cleft flower. It should seem to belong to the *Rubiaceæ*, notwithstanding some points in the description.

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* Mr. R. Brown believes the cells secrete the pollen, and deposit it on the stigma, as the pollen of some *Orchideæ* sticks to any part of the plant. I now readily assent to this, and therefore these plants must remain in *Pentandria*.

6. *Hexandria*. *Aristolochia*, *Engl. Bot. t.* 398, a curious genus, of which there are many exotic species, is the only example of this, *Pistia* being removed to *Monadelphia Octandria*.

7. *Octandria*. The *Scopolia* of Linnæus, which originally constituted this Order, proves to be a *Daphne*; see *Plant. Ic. ex Herb. Linn. t.* 34. *Cytinus* however, *Cavân. Ic. t.* 171, a singular parasitical plant on the roots of *Cistus* in the south of Europe, has properly been brought hither from the Order *Dodecandria*, of which it originally

formed the only example. The observations of Dr. Sibthorp and Mr. Ferd. Bauer confirm those of other botanists, that the anthers are eight, not sixteen, and that they are truly inserted upon the style.

8. *Decandria* is now abolished. Of the two genera which constituted it, *Kleinhovia* belongs to the Class *Dodecandria*, having fifteen stamens, see *Cavan. Monadelph. t.* 146; and *Helicteres* to *Decandria Monogynia.*

9. *Dodecandria* is likewise abolished.

10. *Polyandria* is in a similar predicament, for I am not aware of any genus that can be admitted into it. *Xylopia* goes with the greatest propriety to its natural allies in *Polyandria Polygynia*, *Annona*, &c., its short stamens being inserted into the receptacle below the germen. *Grewia*, as well as Schreber's *Microcos*, a good genus, belong to *Polyandria Monogynia*, the organs of impregnation being merely elevated on a common stalk, like those of *Passiflora* and *Ayenia*. *Ambrosinia*, *Arum*, and *Calla*, are all justly removed by Schreber to *Monoecia*, though I think, for reasons hereafter given, they are more commodiously and naturally placed in the Order *Polyandria* of that Class, than in the Order *Monandria*. *Dracontium* and *Pothos*, of the same natural family, having perfect or united flowers, the former with seven stamens to each, the latter with four, are undoubtedly to be referred to their corre-

sponding Classes, *Heptandria* and *Tetrandria*. *Zostera*, the only remaining genus of *Gynandria Polyandria* in Linnæus, I have long ago ventured to remove to *Monandria Monogynia*; see *Engl. Bot. t.* 467.

Class 21. *Monoecia*. Stamens and Pistils in separate flowers, but both growing on the same individual plant. Orders 9 or 10.

Several reformers of the Linnæan system have also abolished this Class and the two following, by way of rendering that system more simple. Ten years' additional experience since the preface to the seventh volume of *English Botany* was written, have but confirmed my opinion, there given, on this subject. If any plants ought to be removed from these Classes, they must be such as have the structure of all the accessory parts of the flower exactly alike, (the essential parts, or stamens and pistils only, differing,) in both barren and fertile flowers; and especially such as have in one flower perfect organs of one kind, accompanied by rudiments of the other kind, for these rudiments are liable occasionally to become perfect. By this means dioecious species of a genus, as in *Lychnis*, *Valeriana*, *Rumex*, &c., would no longer be a reproach or inconvenience to the system. But, on the other hand, some difficulty would occasionally arise to a student, in deciding whether there were any real difference of structure between these accessory parts or not, and it might puzzle an adept to determine the question. For instance, whether the nectary in *Salix*, different in the barren and fertile flowers of some species, should lead us to keep that genus in *Dioecia*, though in other species the nectary is precisely alike in both the kinds, and occasionally an abortive germen occurs in the barren flowers, as stamens do, more rarely, in some fertile ones. Considering all this, I should refer *Salix* to *Diandria Monogynia*.

With respect to those Monoecious or Dioecious genera whose barren flowers are decidedly unlike the fertile ones, the former being in a catkin, the latter not, as *Corylus*, *Quercus*, &c., I conceive nothing more pernicious or troublesome can be attempted than to remove them to the Classes of united flowers. They meet with no allies there, but, on the contrary, form so natural an assemblage by themselves, as to be unanimously kept separate by the authors of every natural system that has appeared. But even if this were not the case, there is a most important reason for keeping them as they are, which regards the artificial system more particularly, and of which its author was well aware; they are of all plants most uncertain in the number of their stamens. Now this uncertainty is of little moment, when we have them primarily distinguished and set apart from other plants by their Monoecious or Dioecious character; because the genera being few, and the Orders constructed widely as to number of Stamens, we find little difficulty in determining any genus, which would be by no means the case if we had them confounded with the mass of the system. Even the species of the same genus, as well as individuals of each species, differ among themselves. How unwise and unscientific then is it, to take as a primary mark of discrimination, what nature has evidently made of less consequence here than in any other case! It is somewhat like attempting a natural system, and founding its primary divisions on the artificial circumstance of number of stamens.

I proceed to give some illustrations of the Orders in *Monoecia*.

1. *Monandria.* *Zannichellia*, *Mill. Illustr. t.* 77, and *Aegopricon*, *Plant. Ic. ex Herb. Linn. t.* 42, are genuine examples of this Class and Order, having a different structure in the accessory parts of their barren and fertile flowers. *Artocarpus*, the celebrated Bread-fruit, may likewise be esteemed so on account of a partial calyx in the barren flowers. The other amentaceous genera may most intelligibly perhaps be referred to the Order *Polyandria*. *Chara* is now removed to the first Class in the System; see *Engl. Bot. t.* 336.

2. *Diandria.* *Anguria* can remain here only till the proposed reformation takes place, having no difference of structure in its flowers. *Lemna*, so imperfectly known when Linnæus wrote, is now well

understood, and, having frequently united flowers, belongs to the second Class; see *Engl. Bot. t.* 926, 1095, 1233.

3. *Triandria.* The great genus of *Carex*, *t.* 1051, 928, 993—995, &c., and some other grassy plants, are found here. *Typha*, *t.* 1455—1457, is less clear in its structure; *Sparganium*, *t.* 744, 745, 273, is sufficiently so. *Tragia*, *Hernandia* and *Phyllanthus* are properly placed in this Class and Order.

4. *Tetrandria. Littorella*, *t.* 468; the valuable genera *Betula*, *t.* 1508, and *Buxus*, *t.* 1341; also the Nettle *Urtica*, *t.* 1236; are good examples of this. *Morus* the Mulberry, of the same natural order as the Nettle, has scarcely any difference of structure in the accessory organs of the flowers. This tree, however, is remarkable for being often inclined to become even dioecious in its constitution, one individual bearing most fruit when accompanied by another whose barren flowers are more effective than its own. *Empleurum*, *Exot. Bot. t.* 63, is one of those ambiguous genera which are but imperfectly monoecious.

5. *Pentandria. Xanthium*, *Ambrosia*, *Nephelium*, *Parthenium*, *Iva* and *Clibadium* all partake, more or less accurately, of the nature of compound flowers, but their anthers not being united, they

could hardly be referred to the Class *Syngenesia** ; particularly *Xanthium* and *Nephelium*, whose fertile flowers have no resemblance to that Class. *Amaranthus*, an extensive dung-hill genus in warm countries, analogous to our *Chenopodium*, follows next. *Leea* is the same with *Aquilicia*, and belongs to *Pentandria Monogynia*, the former name being retained for the sake of the highly meritorious botanist and cultivator whom it commemorates. The Gourd tribe, *Cucurbita*, *Cucumis*, *Bryonia*, *Engl. Bot. t.* 439, might be brought hither from the abolished Order *Syngenesia*, unless it should be thought better to consider them as polyadelphous, to which I am most inclined.

6. *Hexandria*. *Zizania*, *Tr. of Linn. Soc. v.* 7. *t.* 13; and *Pharus*, *Browne's Jamaica*, *t.* 38, both grasses, compose this Order, to which Schreber has added *Epibaterium* and *Pometia* of Forster, as well as the splendid *Guettarda*, *Hort. Mal. v.* 4. *t.* 48. The latter varies from six to nine in the parts of the flower, and constitutes the Order *Heptandria* in Linnæus, according to his usual principle, of placing such irregular plants, as much as possible, in small Classes or Orders, that they might be the more easily found.

7. *Polyandria*. Stamens more than seven. *Cera-*

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* Willdenow however has removed *Iva* and *Parthenium* thither, according to the original ideas of Linnæus, in *Gen. Pl. ed.* 1.

tophyllum, Engl. Bot. t. 947, 679; *Myriophyllum, t.* 83, 218; and the handsome *Sagittaria, t.* 84, stand here at present, but the accessory parts in their two kinds of flowers are alike. *Begonia, Exot. Bot. t.* 101, has the number of its petals, though various in several species, always sufficiently different in the barren and fertile flowers to fix it here.—The most indubitable plants of this Order are amentaceous, *Quercus, Engl. Bot. t.* 1342; *Fagus, t.* 886; *Corylus, t.* 723; *Carpinus, Juglans, Platanus,* &c.—*Arum, t.* 1298, *Calla* and *Ambrosinia,* all brought hither from the twentieth Class, seem to me perfectly intelligible as simple monoecious flowers, the barren one, with many stamens, being *superior,* or *interior,* with respect to the fertile, like the generality of monoecious, as well as all compound flowers, and not *inferior,* or, as in every simple one, *exterior.*

8. *Monadelphia.* The Fir, *Pinus,* so magnificently illustrated by Mr. Lambert, is very distinct in its two kinds of flowers. Each barren one consists of a naked tuft of monadelphous stamens, accompanied only by a few bracteas at the base. The fertile ones are catkins, with similar bracteas, each scale bearing on its upper side a pair of winged seeds, and on its under a leaf-like style and acute stigma; as Jussieu first, rightly I believe, suggested, though some botanists have understood these parts otherwise. *Aca-*

lypha, *Croton*, *Jatropha*, *Ricinus*, and several others of the natural order of *Euphorbiæ*, acrid milky plants, form a conspicuous and legitimate part of *Monoecia Monadelphia*. *Omphalea* is justly associated with them by Schreber, though placed by Linnæus in the Order *Triandria*, and this alteration is the more fortunate, as one of its species is diandrous. *Sterculia* is best removed to the eleventh Class, next to *Kleinhovia*.

9. *Polyadelphia*. If the system should be preserved in its present state, without regard to agreement or difference in the accessory parts of the barren and fertile flowers, I conceive this Order might be established for the reception of the Gourd tribe, as already hinted under the fifth Order. Their filaments are united, in three sets, a character much more intelligible and constant than the casual and irregular connexion of their anthers, which led Linnæus to reckon them syngenesious; for they only afford an additional proof that union of anthers is, in simple flowers, neither a good natural nor artificial guide. If the monoecious and dioecious Classes be reformed according to the plan to which I have so often adverted, these plants should go to the Class *Polyadelphia*.

10. *Gynandria* is scarcely tenable, being paradoxical in its character, and the two Linnæan genera which compose it, *Andrachne* and *Agyneia*, seem most

properly, even as the system stands at present, to belong to the eighth Order, to great part of which they are, moreover, naturally related.

CLASS 22. *Dioecia.* Stamens and Pistils in separate flowers, situated on two separate plants. Orders 8.

The foregoing remarks on the Orders of *Monoecia* apply also to those of this Class. I shall therefore only briefly mention some genera properly illustrative of each Order, more particularly specifying such as require to be placed elsewhere.

1. *Monandria.* *Brosimum* of Swartz, and *Ascarina* of Forster, seem, by their descriptions, to be well placed here. *Pandanus* (*Athrodactylis* of Forster) is more doubtful, not having any partial calyx or corolla to divide the stamens into separate blossoms, so that the whole may be taken either for a polyandrous or a monadelphous flower, as well as for an assemblage of monandrous ones. *Najas* is a good and immutable example of this Order. Of Thunberg's *Phelypæa* I have not materials to form a judgement.

2. *Diandria.* The wonderful *Valisneria*, already described *p.* 255, is a decisive example of this. *Cecropia* also seems unexceptionable. Of *Salix*, see *Engl. Bot. v.* 20 and 21, &c., I have already spoken, *p.* 358. The scales of its barren and fertile catkins are alike; its nectaries various.

3. *Triandria*. *Elegia* and *Restio*, hard rushy plants, chiefly of the Cape of Good Hope and New Holland, appear to be without any difference in the accessory parts of their flowers, which is certainly the case with *Empetrum*, *Engl. Bot. t.* 526, *Ruscus*, *t.* 560, brought hither from *Dioecia Syngenesia*, *Osyris*, *Excœcaria* and *Maba*; *Caturus* only seeming differently constructed in this particular; but I have not been able to examine the three last.

4. *Tetrandria*. *Trophis*, *Batis*, and *Hippophae*, *t.* 425, are good examples of this, though Mr. Viborg is recorded by Schreber to have occasionally found united flowers, intermixed with the barren ones, in the last-mentioned genus. If this be usual, *Hippophae* must be removed to *Polygamia Dioecia*. The rest of the Order appear to have the accessory parts alike in both flowers, as *Viscum*, *t.* 1470.

5. *Pentandria*. *Humulus*, *t.* 427, is almost the only certain instance here. *Spinacia*, *Acnida* and *Cannabis* would be unexceptionable, but they are less absolutely dioecious, being sometimes monoecious; see *p.* 252. The rest of the Order is at best doubtful; nor can the pretended *amentum* of the barren-flowered *Pistacia* entitle it to a permanent place in this Class, for its fructification is truly a panicle. *Clutia*, more properly *Cluytia*, may possibly remain here. It has no right to a place in the Order *Gynandria*.

6. *Hexandria.* No difference of structure is discernible between the barren and fertile flowers of any genus in this Order; witness *Tamus*, *t.* 91, though something to the contrary is mentioned in the *Genera Plantarum* of Linnæus.

7. *Polyandria.* Under this Order I would certainly comprehend all dioecious plants that have from eight to any greater number of stamens, according to the example set by Linnæus himself in the last Class. The genera are exceedingly variable in this respect; and if all those, the accessory parts of whose flowers are uniform, were taken away, the remainder would be so few, that it is hard to say whether any would remain at all. Instances of the Order as it now stands are *Populus*, *t.* 1618, 1619; *Hydrocharis*, *t.* 808; *Mercurialis*, *t.* 559. The fertile flowers of the latter have, in some cases, a nectary or corolla of two slender leaves, not found in the barren ones, which may entitle it to a permanent place here. *Carica* will also probably remain. *Rhodiola* can scarcely be kept distinct from *Sedum*. *Coriaria* and *Ailanthus*, having often united flowers, are best in the tenth Class, as *Euclea* in the eleventh. I find no genera truly icosandrous here, though Schreber esteems *Flacourtia* and *Hedycarya* to be so.

8. *Monadelphia.* *Taxus*, *t.* 746, and perhaps *Juniperus*, *t.* 1100, also the exotic *Ephedra*, are legiti-

mate examples of this Order. Spurious ones are *Nepenthes*, *Myristica* the Nutmeg, and Schreber's *Xanthe*, all placed by him in the now abolished Order *Syngenesia*, and which can only take shelter here while the Class remains as it is, for they have no difference of structure in the accessory parts of their flowers.

CLASS 23. *Polygamia*. Stamens and Pistils separate in some flowers, united in others, either on the same plant or on two or three distinct ones; such difference in the essential organs being moreover accompanied with a diversity in the accessory parts of the flowers. Orders 3.

1. *Monoecia*. United flowers accompanied with barren or fertile, or both, all on one plant. *Atriplex*, *Engl. Bot. t.* 261, 232, &c., is an instance of this, having the barren flowers of five regular spreading segments, the united ones of two compressed valves, which, becoming greatly enlarged, protect the seed. In several species however the flowers are none of them united, each having only stamens or only pistils. Throughout the rest of the Order, as it stands in Linnæus and Schreber, I can find no genus that has the requisite character. Some of the grasses indeed have awns to one kind of flower only, but that part is too uncertain to establish a character upon; and this family is so natural in itself, and so liable to variations in the perfecting of its flowers or

florets, that there can be no doubt of the propriety of classing its genera simply by the number of their stamens and styles, which are very constant.

2. *Dioecia.* The different flowers on two different plants. I can scarcely find a certain instance of this, except *Hippophae*, already mentioned under *Monoecia Tetrandria.*

3. *Trioecia.* Of the only two genera which have ever been placed here, *Ceratonia*, *Cavan. Ic. t.* 113, belongs to *Pentandria Monogynia.* *Ficus* is so celebrated for the diversity of its flowers, as connected with the history of vegetable impregnation, see *p.* 256, that we are glad to take advantage of a trifling difference in the calyx of the two florets, (the barren one being *most frequently* three-cleft, the fertile five-cleft,) to keep it here.

All things being considered, this Class may be thought scarcely worth retaining. Yet as we know two or three genera entitled to a place in it, upon principles which the analogy of the two preceding Classes shows to be sound, we cannot tell but others may exist in the unexplored parts of the globe. For this reason, and for the uniformity of the system, I would venture to preserve it. If the twenty-first and twenty-second Classes should hereafter be reformed by some judicious and experienced hand, according to the principle I have suggested, of retaining in them such genera only as have a permanent difference in the accessory, as well as the essential, parts of their flowers, their bulk being by such a reformation much diminished, it might be advisable to reduce them to one Class, in which the slender remains of *Polygamia* might commodiously be included, and the title of such a Class should be *Diclinia*; expressing the two distinct seats, or stations, of the organs of fructification.

Class 24. *Cryptogamia.* Stamens and Pistils either not well ascertained, or not to be numbered with any certainty. Orders 5.

1. *Filices.* Ferns. The parts of their flowers are almost entirely unknown. The fructification, taken collectively, and proved to be such by the production of prolific seeds, grows either on the back, summit, or near the base of the frond. Some are called *annulatæ*, annulated, their capsules being bound with an elastic transverse ring; others *thecatæ*, or more properly *exannulatæ*, from the want of such an appendage, of which some of the latter have, nevertheless, a spurious vestige. All the former, and some of the latter, are dorsiferous, bearing fruit on the back of the frond, and of these the fructification is either naked, or else covered with a membranous involucrum. The genera are distinguished by Linnæus according to the shape and situation of the spots, or assemblages of capsules, besides which I have first found it necessary

to take into consideration the absence or presence of the involucrum, and especially the direction in which it bursts. See *Tracts relating to Nat. Hist.* 215, *t.* 1.

Polypodium, *Engl. Bot. t.* 1149, has no involucrum; *Aspidium*, *t.* 1458—1461, has a single, and *Scolopendrium*, *t.* 1150, a double one. *Osmunda*, *t.* 209, has been remarked by Professor Swartz to have a spurious ring. It is one of those ferns the lobes of whose frond are metamorphosed, as it were, into spikes of capsules. *Botrychium* of Swartz, more distinctly spiked, and having no vestige of a ring, is separated by him from *Osmunda*. See one species of it in *Engl. Bot. t.* 318. *Ophioglossum*, *t.* 108, and *Equisetum*, *t.*, 915, 929, are other examples of spiked ferns. Each seed of the latter is embraced by four filaments, judged by Hedwig to be the stamens. Supposed ferns, with radical fructifications, are *Pilularia*, *t.* 521, and *Isoetes*, *t.* 1084; but the former might possibly be referred to *Monoecia Polyandria*, and the latter to *Monoecia Monandria*, as the system at present stands. *Lycopodium*, *t.* 224, 1148, &c., is a fern, at least in my opinion, with axillary fructification.

2. *Musci*. Mosses. These are really herbs* with distinct leaves and frequently as distinct a stem. Their conical membranous corolla is called a *calyptra*,

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* Hedwig's term *musci frondosi* is incorrect.

f. 151, or veil, its summit being the stigma. This veil clothes the capsule, which, before the seed ripens, is elevated on a fruit-stalk. The capsule is of one cell and one valve, opening by a vertical lid, *f.* 213.* Seeds very numerous and minute. The barren flowers of mosses consist of an indefinite number of nearly cylindrical, almost sessile, anthers, *f.* 190; the fertile flowers, of one (rarely more) perfect pistil, accompanied by several barren pistils, *f.* 192. Both stamens and pistils are intermixed with numerous succulent jointed threads, *f.* 191, which perhaps answer the purpose of a calyx or corolla, as far as protection is concerned. Some few species of moss have the stamens and pistils associated in the same flower, but they are generally separate. *Hypnum*, *Engl. Bot. t.* 1424, 1425, has a scaly sheath, or *perichætium*, *f.* 150, at the base of its fruit-stalk, composed of leaves very different from the foliage of the plant. This is considered as a sort of calyx, see *p.* 192, and as such is allowed to enter into the generic character; but there is some reason to esteem it rather of the nature of bracteas. The capsule of *Splachnum*, *Engl. Bot. t.* 144, &c., stands on a peculiar fleshy base, called *apophysis*, *f.* 189 a.

Micheli in his *Genera Plantarum*, published in 1729, *tab.* 59, has well represented the parts above described, though he mistook their use, being quite ignorant of the fecundation of plants. Dillenius took the one flower precisely for the other, and yet absurdly called *capsula* what he believed to be *anthera*. Linnæus, who had previously formed just ideas on the subject, as appears from his Tour to Lapland, too implicitly submitted his own judgement to that of Dillenius, and adopted his hypothesis, at the same time correcting, as he thought, his phraseology. Hence the whole glare of the blunder of Dillenius has fallen on Linnæus; for while we read, in the Linnæan definitions of mosses, every where the word *anthera*, and in those of Dillenius, usually accompanying them, *capsula;* few persons, who have lately been instructed by Hedwig that the part in question is really a capsule, take the trouble to recollect that Dillenius so grossly misused that word. Various ideas have been started on this subject by Haller, Necker, and others, which could only claim attention while it remained in great obscurity. The excellent Hedwig has entirely the merit of an original discoverer in this branch of physiology. He examined all that had been done before his time, detected the truth, raised mosses from seed, *f.* 193—196, and established their characters on the principles we have already explained.

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* This part in *Phascum* only does not separate from the capsule.

The Linnæan genera of Mosses are chiefly founded on the situation of the capsule, whether lateral or terminal, with some other circumstances. They are too few, and not strictly natural. Hedwig first brought into notice the structure of the fringe, *peristomium*, which in most mosses borders the orifice of the capsule. This is either simple, *f.* 189 b, or double, *f.* 213, 214, and consists either of separate teeth, or of a plaited and jagged membrane. The external fringe is mostly of the former kind, the inner, when present, of the latter. The number of teeth, remarkably constant in each genus and species, is either four, eight, sixteen, thirty-two or sixty-four. On these therefore Hedwig and his followers have placed great dependence, only perhaps going into too great refinements relative to the internal fringe, which is more difficult to examine, and less certain, than the outer. Their great error has been laying down certain principles as absolute in forming genera, without observing whether all such genera were natural. Such mistakes are very excusable in persons not conversant with botany on a general scale, and whose minute and indefatigable attention to the detail of their subject, more than compensates the want of what is easily supplied by more experienced systematics. Thus *Barbula* of Hedwig is separated from *Tortula*, *Engl. Bot.* *t.* 1663, and *Fissidens* from *Dicranum*, *t.* 1272, 1273, on account of a difference of form or situation in the barren flowers, which is evidently of no moment, and merely divides genera that ought to be united. The same may be said of genera founded on the union of the stamens and pistils in one flower. On this subject I have been more diffuse in a paper on *Mnium*, in *Tr. of Linn. Soc. v.* 7. 254, to which I beg leave to refer those who are desirous of studying it further. Various and abundant specimens of this tribe of plants, showing the various structure of the fringe, lid and other parts, may be seen in the latter volumes of *English Botany* more especially.

Mosses are found in the hottest and coldest climates. They are extremely tenacious of life, and, after being long dried, easily recover their health and vigour by moisture. Their beautiful structure cannot be too much admired. Their species are numerous, and in some cases difficult to determine, particularly in the genera *Tortula* and *Orthotrichum*; nor is the generic character of the latter so easy or certain as most others. Schreber, Dickson, Swartz, Bridel, Weber, Mohr and Turner are great names in this department of Botany, besides those of whom we have already spoken.

3. *Hepaticæ*. Liverworts. Of these the herbage is commonly frondose, the fructification originating from what is at the same time both leaf and stem. This character, however, proves less absolute than one founded on their capsules, which differ essentially from those of the preceding Order in having nothing like a lid or *operculum*. The *corolla*, or

veil, of some of the genera is like that of Mosses, but usually bursts at the top. The barren flowers in some are similar to the stamens of the last-mentioned plants, as in *Jungermannia*, see Hedwig's *Theoria*, *t.* 16*; in others they are of some peculiar conformation, as in *Marchantia*, *Engl. Bot. t.* 210, where they are imbedded in a disk like the seeds of Lichens, in a manner so contrary to all analogy, that botanists can scarcely agree which are the barren and which the fertile flowers of this genus. The four-valved capsule of *Jungermannia*, with the veil bursting at its summit to let the fruit-stalk pass, may be seen in *Engl. Bot. t.* 185, 186, which are both frondose species, like *J. epiphylla*, *t.* 771, whose calyx as well as corolla is evident; and *t.* 605—608, which have apparently distinct leaves, like Mosses. *Anthoceros*, *t.* 1537, 1538, is a curious genus of the *Hepaticæ*. Linnæus comprehended this Order under the following one, to which it is, most assuredly, far less akin than to the foregoing.

4. *Algæ*. Flags. In this Order the herbage is frondose, sometimes a mere crust, sometimes of a leathery or gelatinous texture. The seeds are imbedded, either in the frond itself, or in some peculiar receptacle. The barren flowers are but imperfectly known. Here we find that great natural

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* See also Mr. W. J. Hooker's valuable Monograph on *Jungermannia*, *t.* 13, where the anthers are ascertained to be membranous, discharging the pollen at the apex.

Order, comprehended by Linnæus under one genus by the name of *Lichen*, the fructification of which, for the most part, consists of a smooth round disk, *f.* 198, flat, convex, or concave, with or without an adventitious border, in the substance of which disk the seeds are lodged. In some others they are placed in powdery warts, or in fibrous receptacles. The barren flowers are supposed to be powdery also, *f.* 197, very much like those of *Jungermannia*. See *Engl. Bot. t.* 126, and various other parts of that work, where a great number of species are figured. The whole tribe has been much investigated, and attempted to be divided into natural genera founded on habit, by Dr. Hoffmann of Goettingen, whose figures are perfect in their kind. But a more complete scheme for reducing this family to systematic order has been made known to the world by Dr. Acharius, a learned Swede, who in his *Prodromus*, and *Methodus Lichenum*, has divided it into genera founded on the receptacle of the seeds alone. Hence those genera, though more technical, are less natural than Hoffmann's; but they will, most likely, prove the foundation of all that can in future be done on the subject, and the works of Acharius form a new æra in cryptogamic botany. It is only perhaps to be regretted that he has been somewhat too prodigal of new terms, which when not wanted are always a burthen to science, and rather obscure than illustrate it, Thus Hedwig used the term *sporangium* for a seed-vessel, *pericarpium*, in which the learner would seek in vain for any distinction, or new idea. A student might very justly complain if, in a science necessarily so overburthened with words, he were required to call the same part by a different name in every different family. I would gladly therefore retain the word *frons* in preference to the *thallus* of Acharius, *receptaculum* for his *apothecium*, *pedicellus* for his *bacillum* or *podetium*, and *semina* for his *sporæ*, because I see no improvement in the change. When this or any other writer strikes out new ideas, and discriminates parts hitherto mistaken or unknown, we thankfully receive from him new terms to express his discoveries. Thus the *cyphella* of Acharius is a peculiar sort of pit or pore, on the under side of the frond, in that section of Lichens called *Sticta*, see *Engl. Bot. t.* 1103, 1104; his *lirellæ* are the black letter-like receptacles of the genus *Opegrapha*, *t.* 1753—1756; his *tricæ* the analogous parts, resembling a coiled horse-hair, in *Gyrophora*, the *Umbilicaria* of Hoffmann, *t.* 522. These terms are necessary and instructive, and are chosen with that accuracy and taste for which Dr. Acharius is conspicuous.

The aquatic or submersed *Algæ* form a distinct and peculiar tribe. Some of these abound in fresh water, others in the sea, whence the latter are commonly denominated sea-weeds. The chief genera are *Ulva*, *t.* 419, 420, 1276, well defined by its seeds being dispersed under the cuticle throughout the membranous or gelatinous substance of the frond; *Fucus*, *t.* 1066—1069, &c., whose seeds are collected together in tubercles or swellings, of various forms and sizes; and *Conferva*, of which the twenty-fourth and twenty-fifth volumes of *Engl. Bot.*, more especially, show various specimens. This last genus is commonly known by its capillary, and, for the most part, jointed frond. The seeds of some species are lodged in external capsules or tubercles; of others in the joints of the frond; and hence the ingenious Dr. Roth has formed a genus of the former, called *Ceramium*. His *Rivularia*, *Engl. Bot. t.* 1797—1799, is perhaps more satisfactorily separated from *Conferva*, as we trust is *Vaucheria*, *t.* 1765, 1766, a fresh-water genus named after *M. Vaucher* of Geneva, who has published an elaborate and faithful microscopical work on Fresh-water Confervas. The submersed *Algæ* in general are merely fixed by the roots, their nourishment being imbibed by their surface. Many of them float without being attached to any thing. The genus *Fucus* has received more botanical attention than the rest of this tribe; and the works of Gmelin, Esper, Stackhouse and Velley have ascertained many species, which the labours of Dr. Goodenough, Mr. Woodward and Mr. Turner have reduced to systematic order. Still a more perfect combination of the skill of the painter and the botanist has long been desired, relative to the genus in question, which is now supplied by the *Historia Fucorum* of the writer last mentioned, and his friend Mr. W. J. Hooker.

5. *Fungi.* Mushrooms. These cannot properly be said to have any herbage. Their substance is fleshy, generally of quick growth and short duration, differing in firmness, from a watery pulp to a leathery or even woody texture. By some naturalists they have been thought of an animal nature, chiefly because of their fœtid scent in decay, and because little white bodies like eggs are found in them at that period. But these are truly the eggs of flies, laid there by the parent insect, and destined to produce a brood of maggots, to feed on the decaying *fungus*, as on a dead carcase. Ellis's beautiful discoveries, relative to corals and their inhabiting polypes, led to the strange analogical hypothesis that these insects formed the *fungus*, which Munchausen and others have asserted. Some have thought *fungi* were composed of the sap of corrupted wood, transmuted into a new sort of being; an idea as unphilosophical as the former, and unsupported by any semblance of truth.

Dryander, Schæffer and Hedwig have, on much better grounds, asserted their vegetable nature, detected their seeds, and in many cases explained their parts of fructification. In fact, they propagate their species as regularly as any other organized beings, though, like others, subject to varieties. Their sequestered and obscure habitations, their short duration, their mutability of form and substance, render them indeed more difficult of investigation than common plants, but there is no reason to suppose them less perfect, or less accurately defined. Splendid and accurate works, illustrative of this Order, have been given to the world by Schæffer, Bulliard and Sowerby, which are the more useful, as the generality of *fungi* cannot well be preserved. The most distinguished writer upon them, indeed the only good systematic one, is Persoon, who has moreover supplied us with some exquisite figures. His *Synopsis Methodica Fungorum* helps us to the following arrangement.

1. *Angiocarpi*, such as bear seeds internally. These are either hard, like *Sphæria*, *Sowerb. Fung. t.* 159, 160; or membranous, tough and leathery, like *Lycoperdon*, *t.* 331, 332; *Cyathus* (*Nidularia*) *t.* 28, 29; or *Batarrea* (*Lycoperdon*) *t.* 390.

2. *Gymnocarpi*, such as bear seeds imbedded in an appropriate, dilated, exposed membrane, denominated *hymenium*, like *Helvella*, *t.* 39, in which that part is smooth and even; *Boletus*, *t.* 34, 87, 134, in which it is porous; and the vast genus *Agaricus*, *t.* 1, 2, &c., in which it consists of parallel plates called *lamellæ*, or gills.

Persoon has been commendably sparing of new terms. Besides *hymenium* above explained, he has scarcely introduced any other than *peridium*, for the round membranous dry case of the seeds in some of the first section. The term *pileus*, a hat, is used by all authors for the head of those *fungi* that compose the second section.

APPENDIX. *Palmæ.* The natural order of Palms was so little understood when Linnæus formed his systematical arrangement of plants, and so few of their flowers had been scientifically examined, that he was under the necessity of leaving this order as an appendix to his system, till it could be better investigated. To its peculiar habit and physiology we have adverted in several of the foregoing pages, see *p.* 45, 48, 103, &c.

Late observations show Palms to have for the most part six stamens, rarely three or nine, with three or six petals, and one or three styles; which last are sometimes in the same flower with the stamens, sometimes in a separate one, but both flowers always agree in general structure. Their fruit is generally a *drupa.* They are akin to the *liliaceous* tribe, and Linnæus happily terms them the princes of the vegetable kingdom. His most numerous remarks concerning them occur in his *Prælectiones in Ordines Naturales Plantarum*, published by Professor Giseke at Hamburgh in 1792, from private lectures and conversations of Linnæus. This work however is necessarily full of errors and mistakes, not only from its mode of compilation and the intricacy of the subject, but because Linnæus had only partially studied certain parts of that subject, and was undecided in his sentiments upon those parts. It was a singular instance of indulgent liberality in him to allow his disciples Fabricius and Giseke to make notes, for their own use, of what he considered himself as scarcely competent to lay in a finished form before the public. We are obliged to the editor for preserving these valuable though crude materials, and he has shown ability in digesting and elucidating them. I should scarcely, for my own part, have thought it right to furnish still more crude and imperfect guesses and opinions, from manuscripts which their illustrious author had purposely, as it appears, withheld from his auditors, lest he should lead them into error. This will explain a note in Professor Giseke's preface, *p.* 19, which however was printed before his request came to my knowledge; for two very intelligent friends, through whom it was meant to be conveyed, judged it unreasonable to be made, as well as improper to be complied with, and therefore suppressed the message.

I have only to add a few practical remarks on the preparation and use of an *Herbarium* or *Hortus Siccus*. The advantages of preserving specimens of plants, as far as it can be done, for examination at all times and seasons, is abundantly obvious. Notwithstanding the multitude of books filled with descriptions and figures of plants, and however ample or perfect such may be, they can teach no more than their authors observed; but when we have the works of Nature before us, we can investigate them for ourselves, pursuing any train of inquiry to its utmost extent, nor are we liable to be misled by the errors or misconceptions of others. A good practical botanist must be educated among the wild scenes of nature, while a finished theoretical one requires the additional assistance of gardens and books, to which must be superadded the frequent use of a good herbarium. When plants are well dried, the original forms and positions of even their minutest parts, though not their colours, may at any time be restored by immersion in hot water. By this means the productions of the most distant and various countries, such as no garden could possibly supply, are brought together at once under our eyes, at any season of the year. If these be assisted with drawings and descriptions, nothing less than an actual survey of the whole vegetable world, in a state of nature, could excell such a store of information.

Some persons recommend the preservation of specimens in weak spirits of wine, and this mode is by far the most eligible for such as are very juicy. But it totally destroys their colours, and often renders their parts less fit for examination than the above-mentioned mode. It is besides incommodious for frequent study, and a very expensive and bulky way of making an herbarium.

The greater part of plants dry with facility between the leaves of books, or other paper, the smoother the better. If there be plenty of paper, they often dry best without shifting; but if the specimens are crowded, they must be taken out frequently, and the paper dried before they are replaced. The great point to be attended to is that the process should meet with no check. Several vegetables are so tenacious of their vital principle, that they will grow between papers, the consequence of which is a destruction of their proper habit and colours. It is necessary to destroy the life of such, either by immersion in boiling water, or by the application of a hot iron, such as is used for linen, after which they are easily dried. I cannot however approve of the practice of applying such an iron, as some persons do, with great labour and perseverance, till the plants are quite dry, and all their parts incorporated into a smooth flat mass. This renders them unfit for subsequent examination, and destroys their natural habit, the most important thing to be preserved. Even in spreading plants between papers, we should refrain from that precise and artificial disposition of their branches, leaves, and other parts, which takes away from their natural aspect, except for the purpose of displaying the internal parts of some one or two of their flowers, for ready observation.

After all we can do, plants dry very variously. The blue colours of their flowers generally fade, nor are reds always permanent. Yellows are much more so, but very few white flowers retain their natural aspect. The Snowdrop and *Parnassia*, if well dried, continue white. Some greens are much more permanent than others; for there are some natural families whose leaves as well as flowers turn almost black by drying, as *Melampyrum*, *Bartsia*, and their allies, several Willows, and most of the *Orchideæ*. The Heaths and Firs in general cast off their leaves between papers, which appears to be an effort of the living principle, for it is prevented by immersion of the fresh specimen in boiling water. *Nandina domestica*, a Japanese shrub, lately introduced among us by Lady A. Hume and Mr. Evans of Stepney, is very remarkable in this respect. Every leaflet of its very compound leaves separates from its stalk in drying, and even those stalks all fall to pieces at their joints.

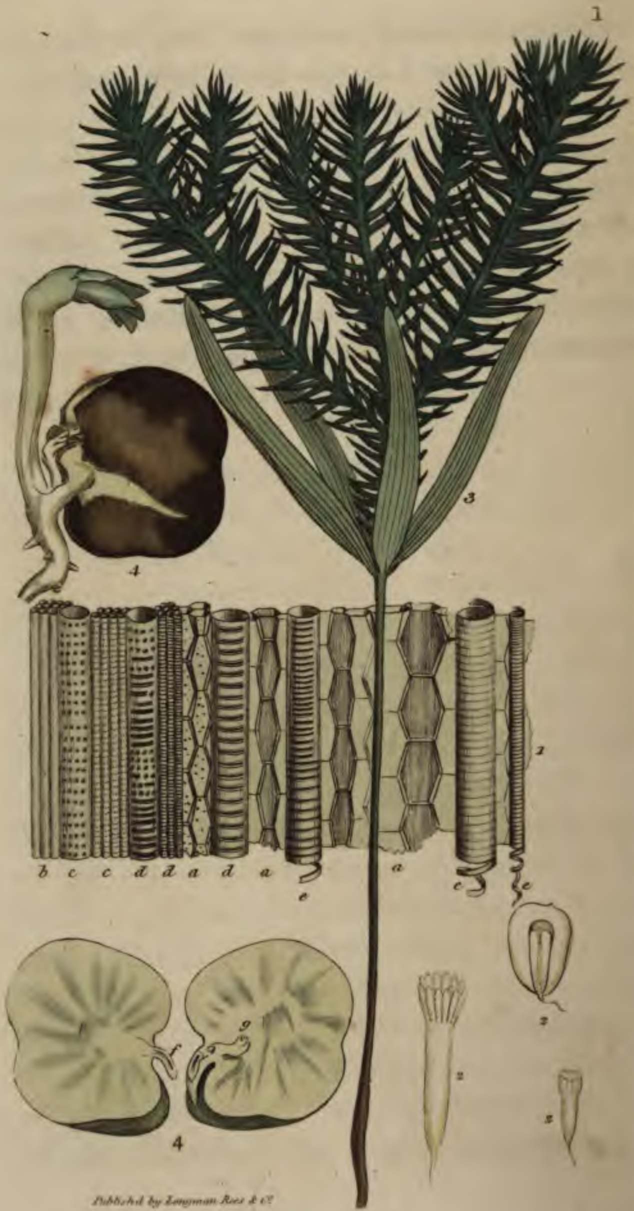
Dried specimens are best preserved by being fastened, with weak carpenter's glue, to paper, so that they may be turned over without damage. Thick and heavy stalks require the additional support of a few transverse strips of paper, to bind them more firmly down. A half sheet, of a convenient folio size, should be allotted to each species, and all the species of a genus may be placed in one or more whole sheets. On the latter the name of the genus should externally be written, while the name of every species, with its place of growth, time of gathering, the finder's name, or any other concise piece of information, may be inscribed on its appropriate paper. This is the plan of the Linnæan Herbarium, in which every species, which its original possessor had before him when he wrote his great work the *Species Plantarum*, is numbered both in pencil and in ink, as well as named, the former kind of numbers having been temporary till the book to which they refer was printed, after which they were confirmed with a pen, and a copy of the book, now also in my hands, was marked in reference to them. Here therefore we do not depend on the *opinion* merely, even of Linnæus, for we have always before our eyes the very object which was under his inspection. We have similar indications of the plants described in his subsequent works, the herbarium being most defective in those of his second *Mantissa*, his least accurate publication. We often find remarks there, made from specimens acquired after the *Species Plantarum* was published. These the herbarium occasionally shows to be of a different species from the original one, and it thus enables us to correct such errors.

The specimens thus pasted, are conveniently kept in lockers, or on the shelves of a proper cabinet. Linnæus in the *Philosophia Botanica* exhibits a figure of one, divided into appropriate spaces for each class, which he supposed would hold his whole collection. But he lived to fill two more of equal size, and his herbarium has been perhaps doubled since his death by the acquisitions of his son and of its present possessor.

One great and mortifying impediment to the perfect preservation of an herbarium arises from the attacks of insects. A little beetle called *Ptinus Fur* is, more especially, the pest of collectors, laying its eggs in the germens or receptacles of flowers, and others of the more solid parts, which are speedily devoured by the maggots when hatched, and by their devastations paper and plants are alike involved in ruin. The most bitter and acrid tribes, as *Euphorbia*, *Gentiana*, *Prunus*, the Syngenesious class, and especially Willows, are preferred by these vermin. The last-mentioned family can scarcely be thoroughly dried before it is devoured. Ferns are scarcely ever attacked, and grasses but seldom.—To remedy this inconvenience I have found a solution of corrosive sublimate of mercury in rectified spirits of wine, about two drams to a pint, with a little camphor, perfectly efficacious. It is easily applied with a camel-hair pencil when the specimens are perfectly dry, not before; and if they are not too tender, it is best done before they are pasted, as the spirit extracts a yellow dye from many plants, and stains the paper. A few drops of this solution should be mixed with the glue used for pasting. This application not only destroys or keeps off all vermin, but it greatly revives the colours of most plants, giving the collection a most pleasing air of freshness and neatness.

After several years' experience, I can find no inconvenience from it whatever, nor do I see that any dried plants can long be preserved without it.

The herbarium is best kept in a dry room without a constant fire. Linnæus had a stone building for his museum, remote from his dwelling-house, into which, I have been told, neither fire nor candle was ever admitted, yet nothing can be more free than his collection from the injuries of dampness, or other causes of decay.



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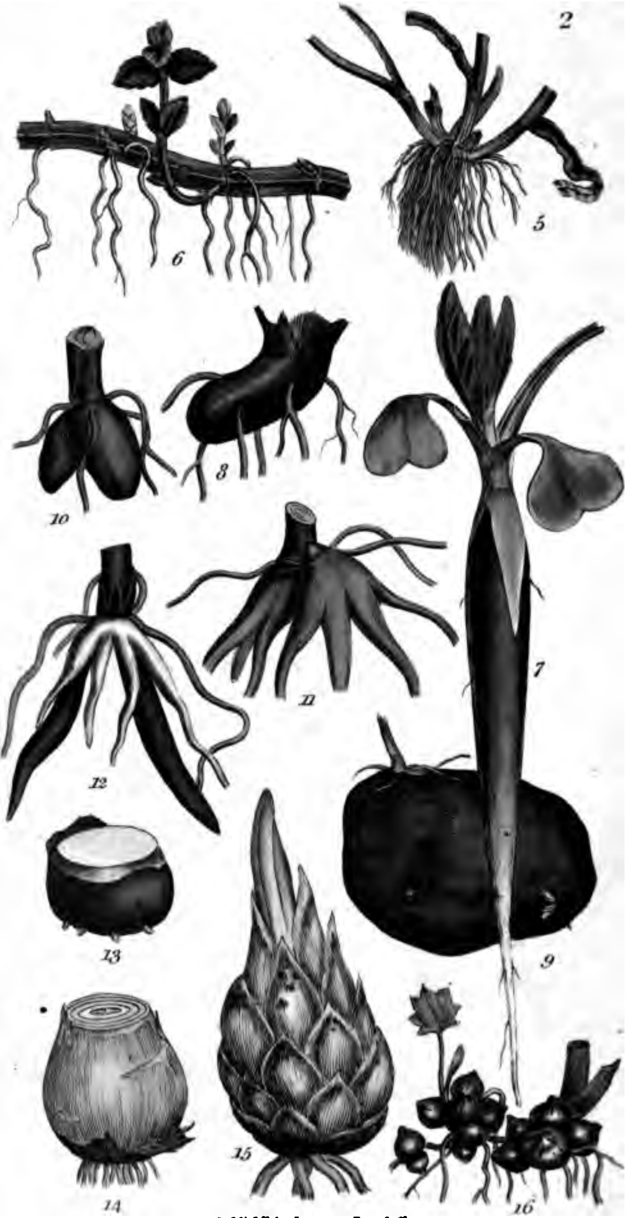

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EXPLANATION OF THE PLATES.

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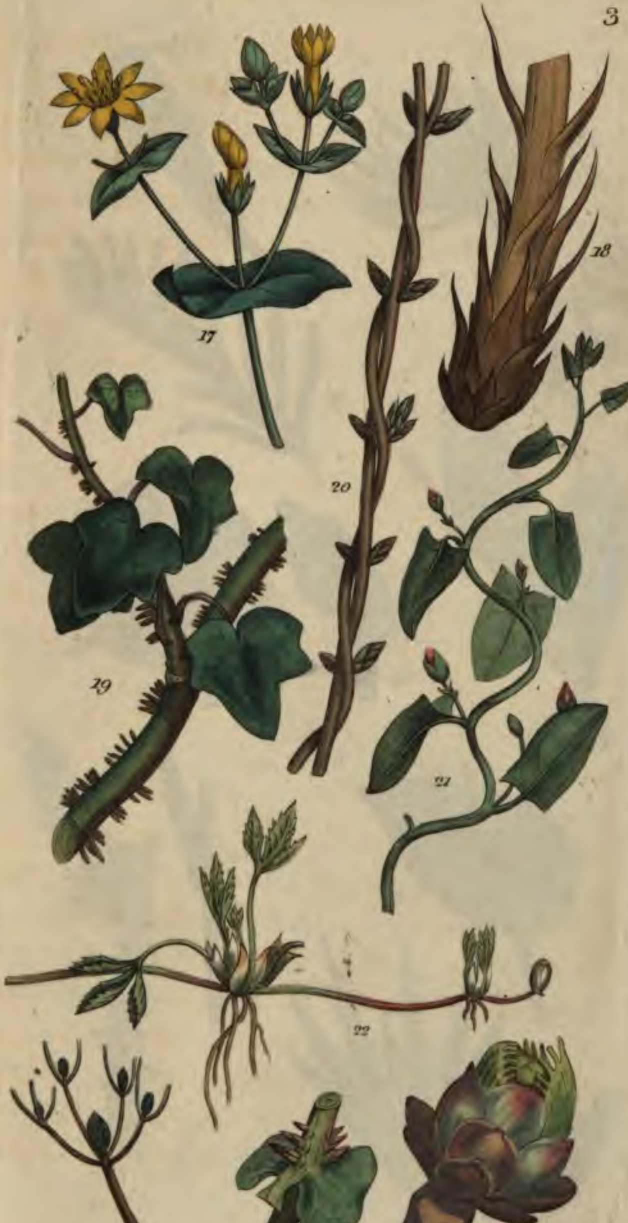

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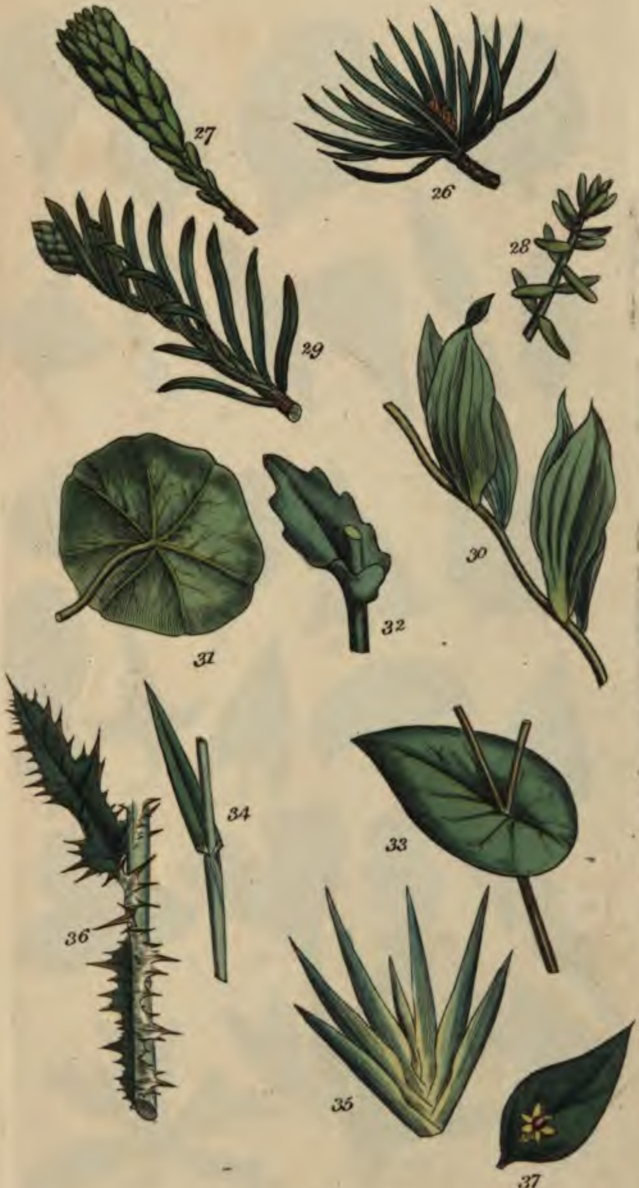

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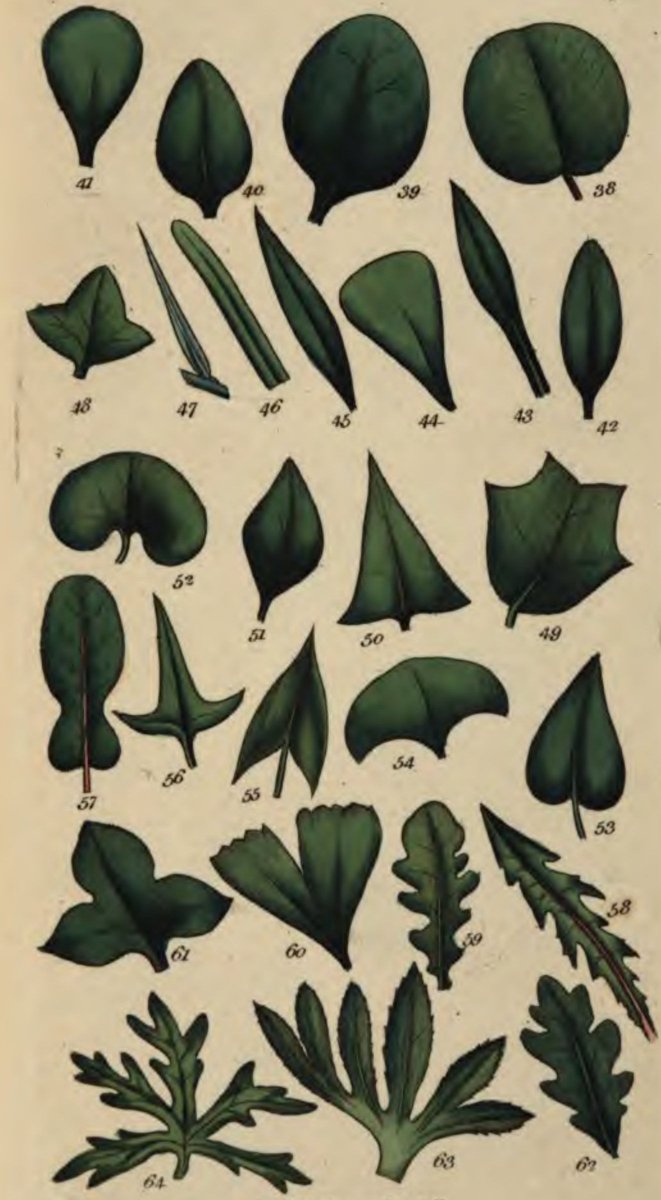

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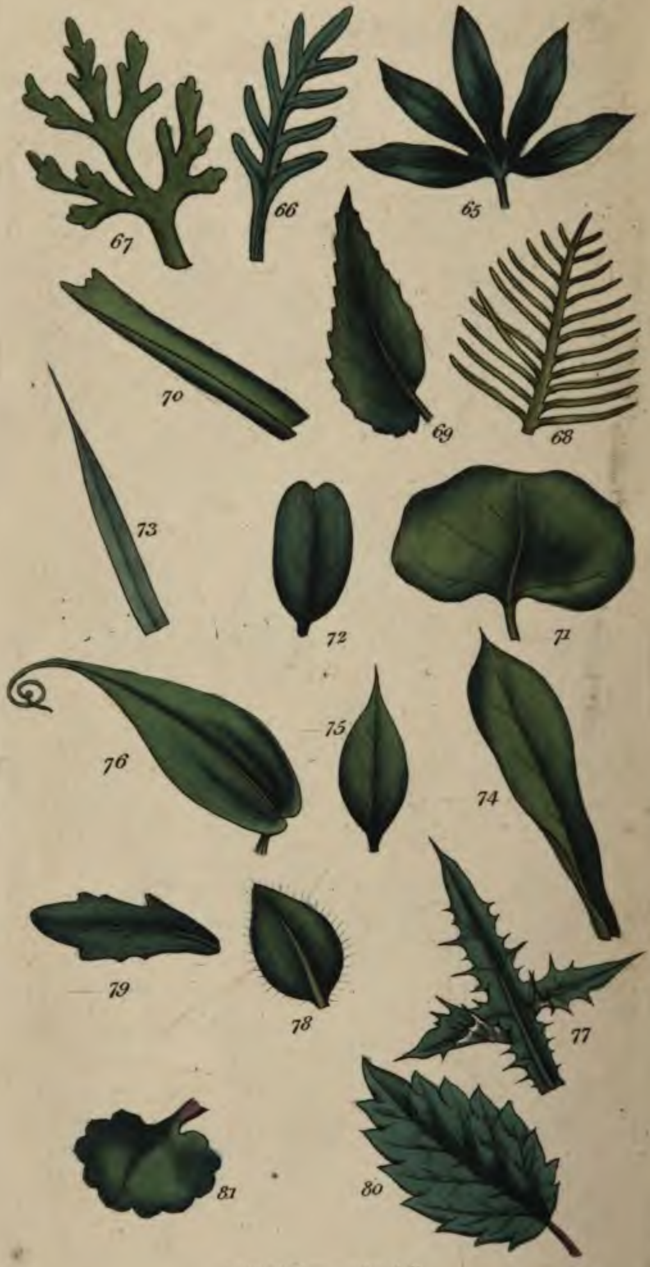

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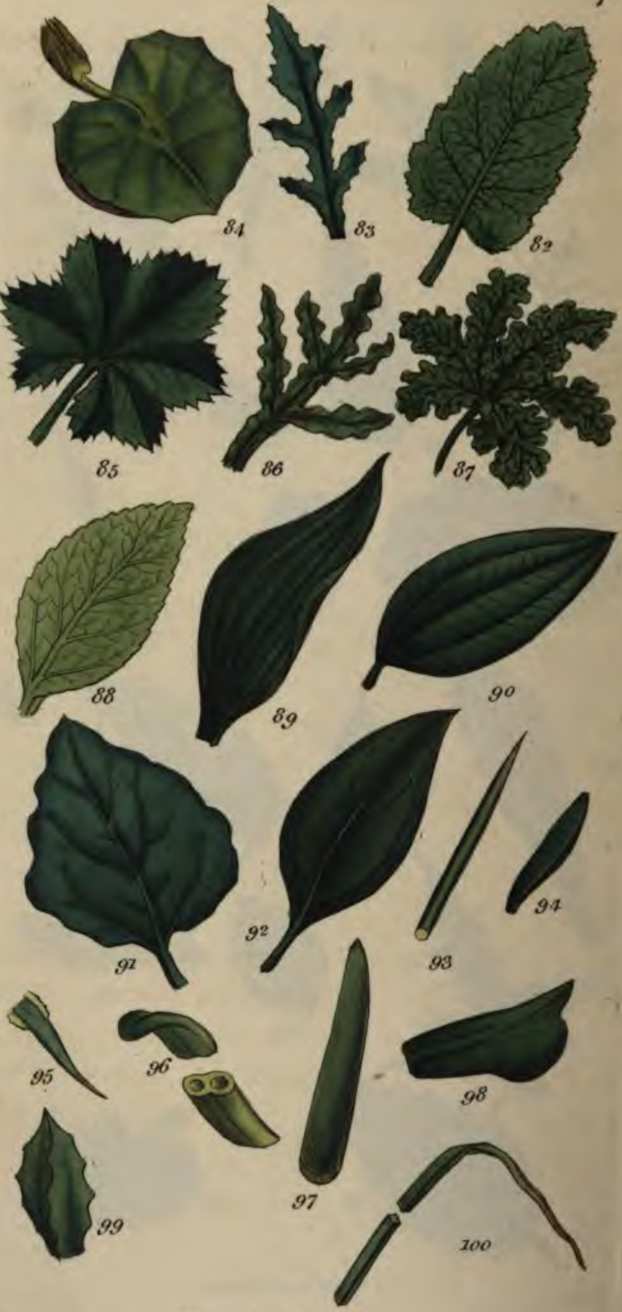

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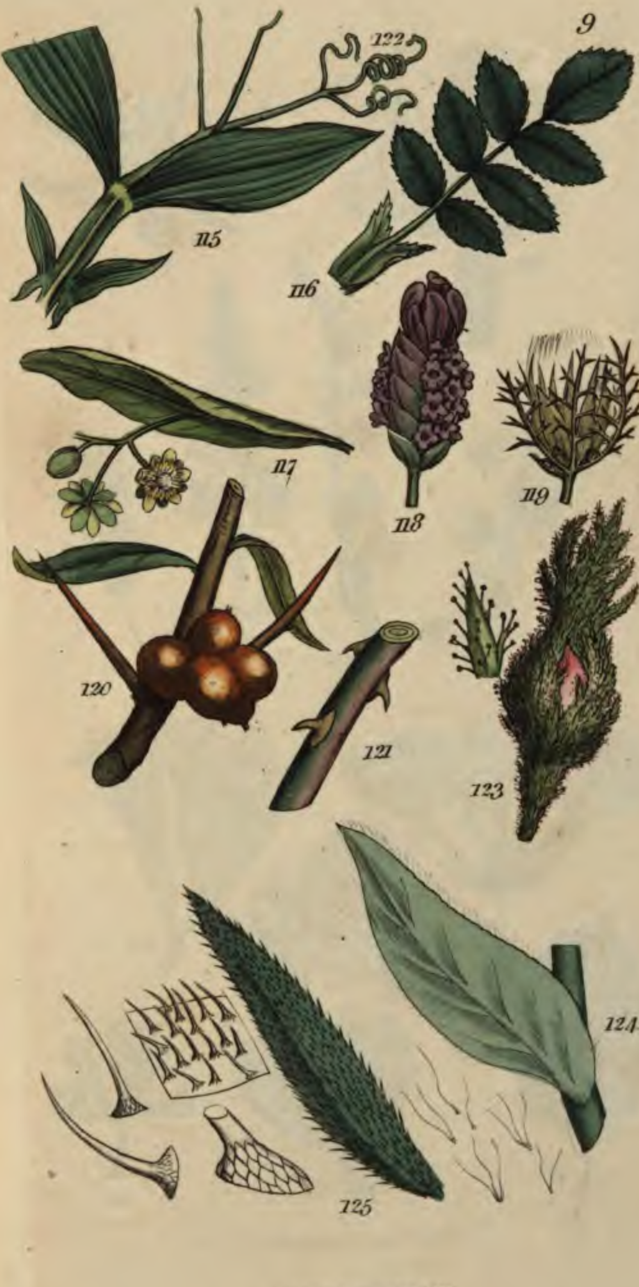

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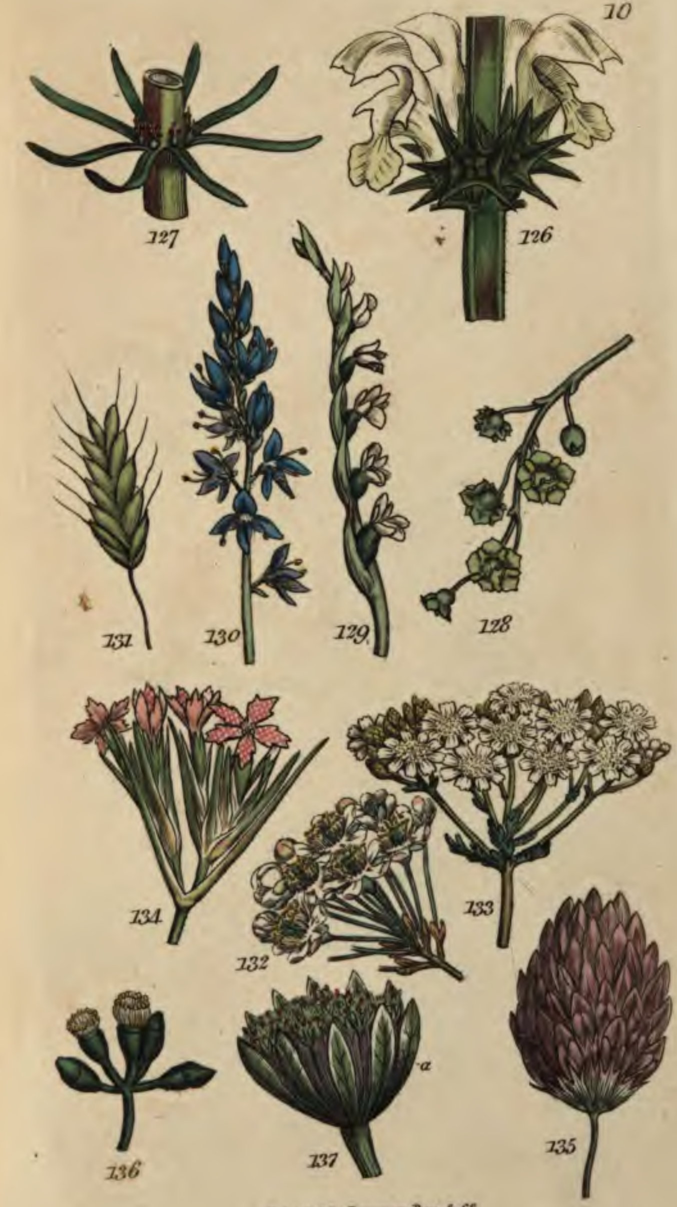

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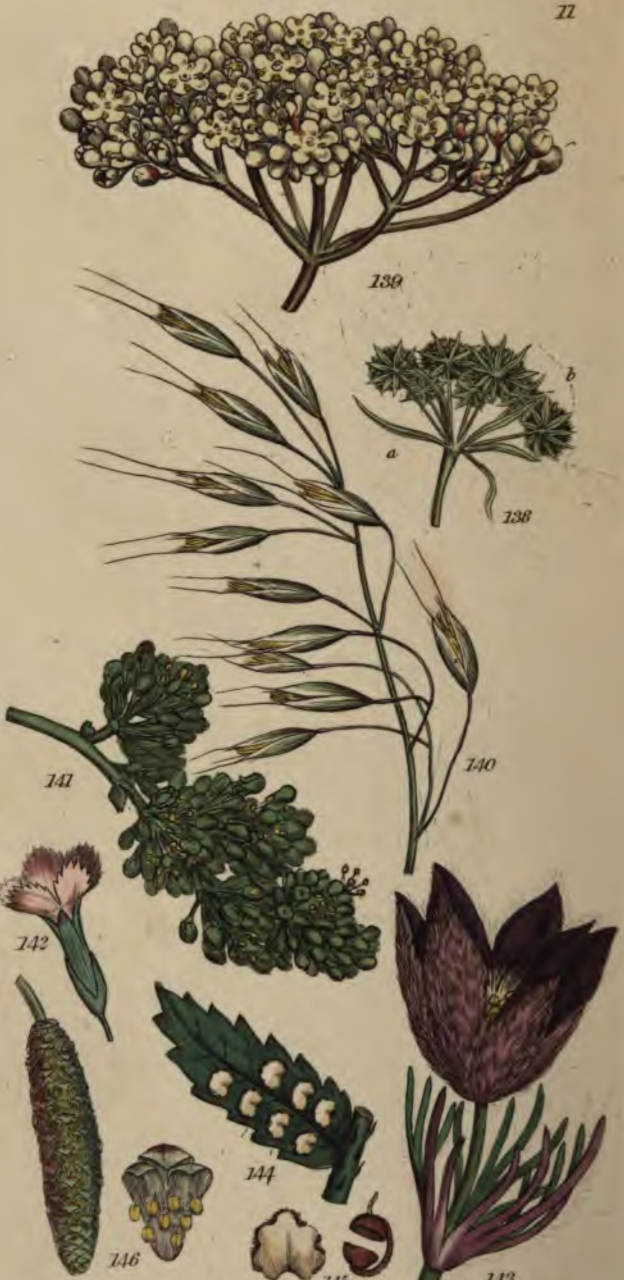

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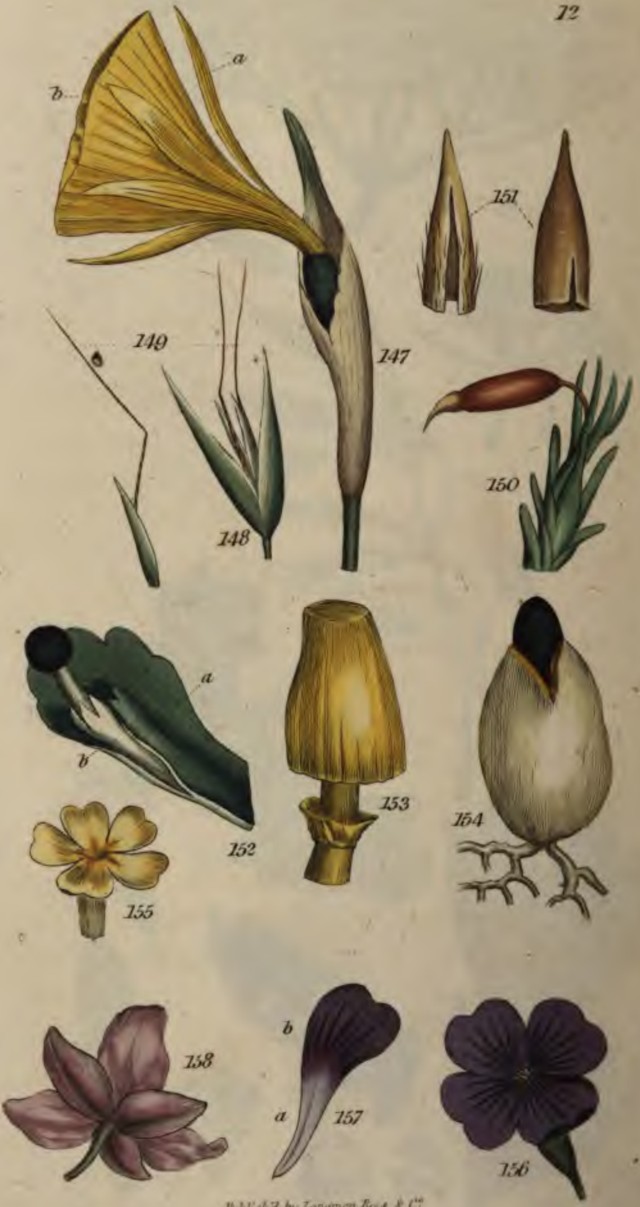

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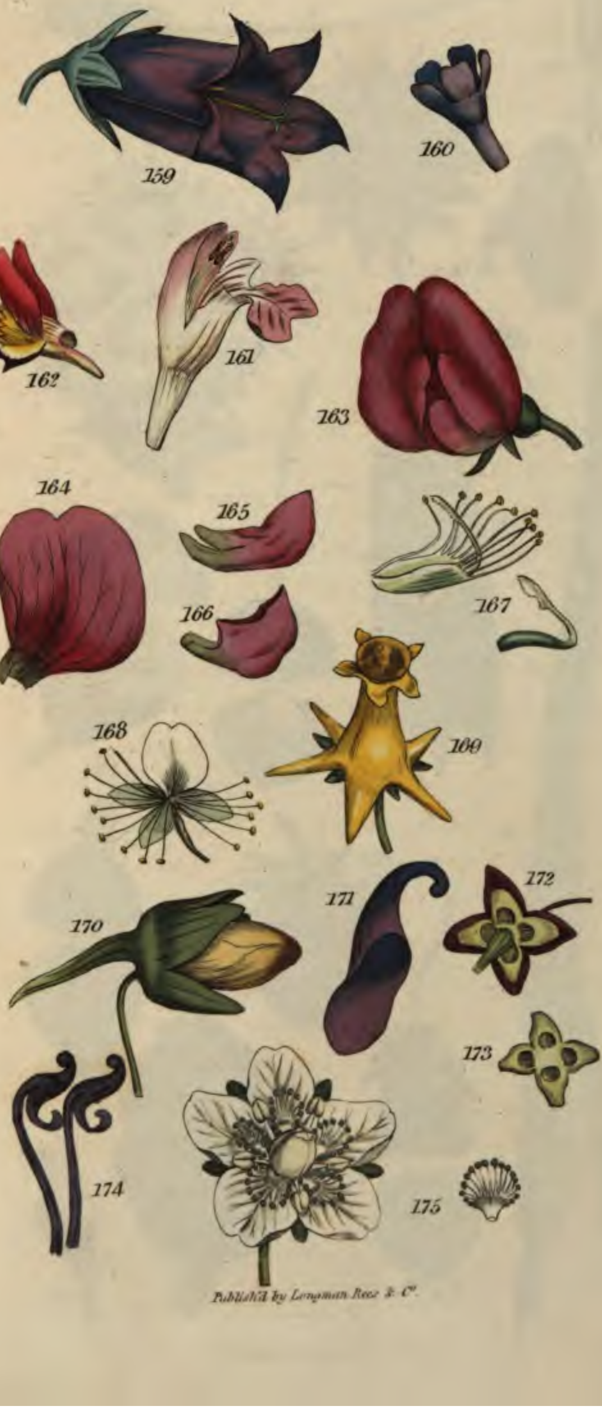

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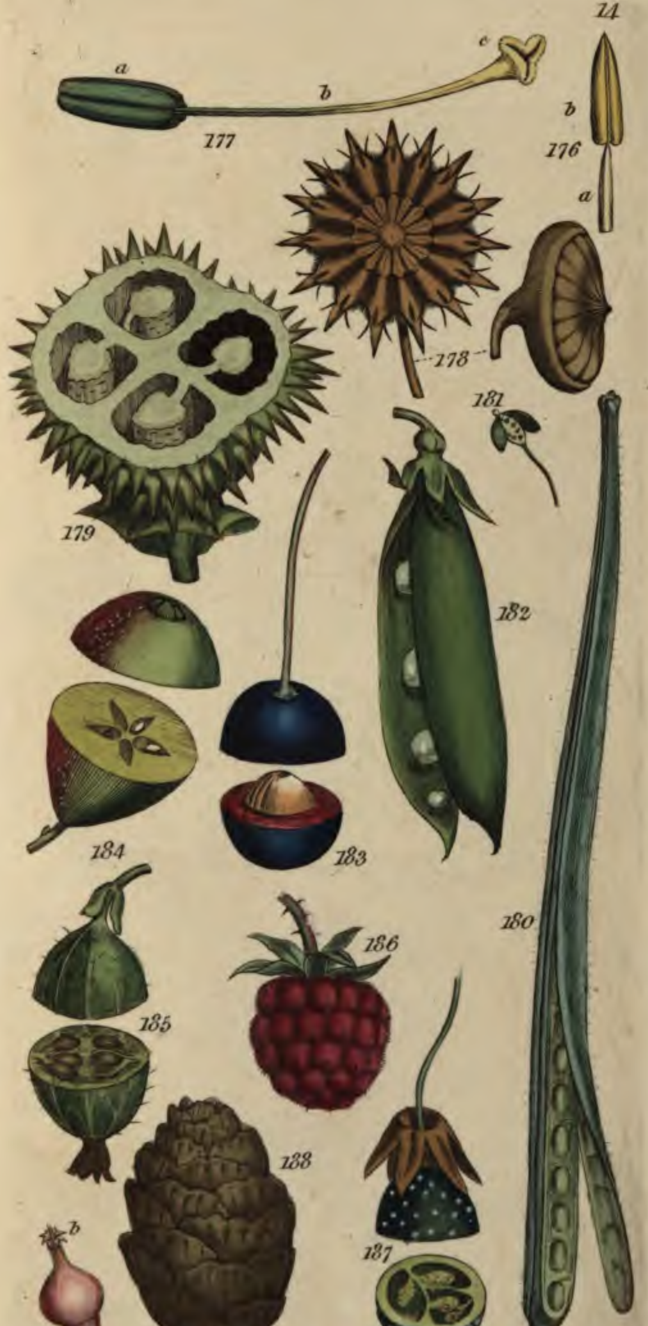

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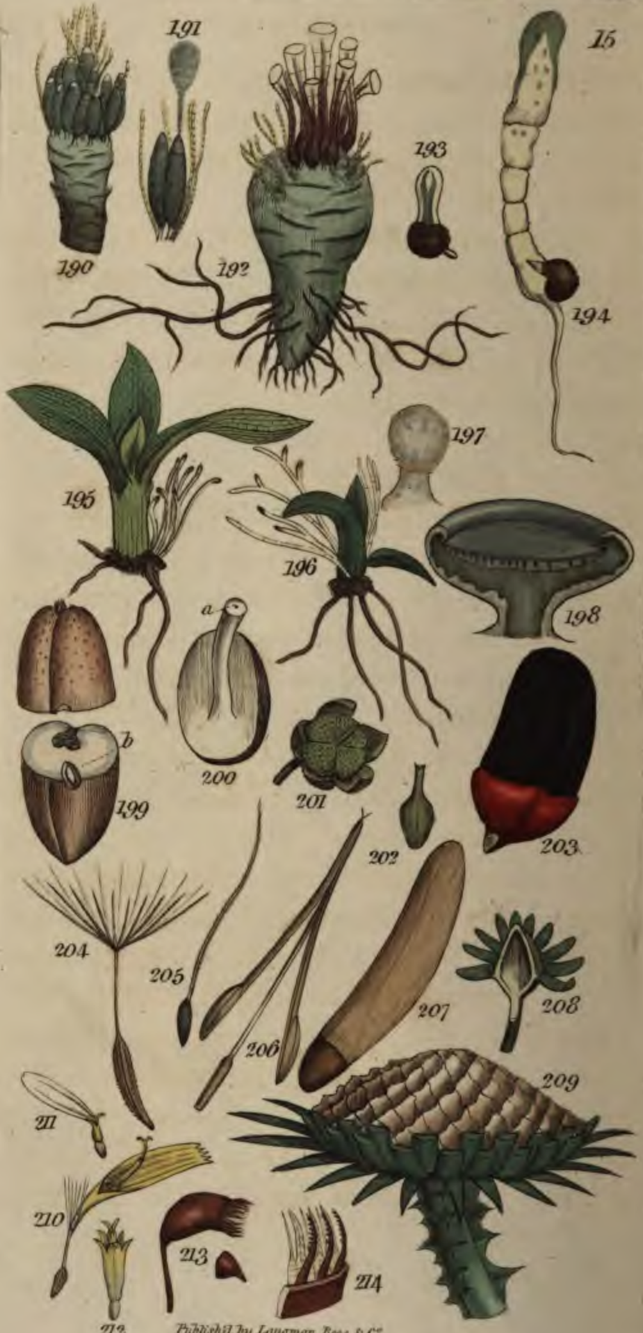

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